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Engine Driven Gang Punching Machine.

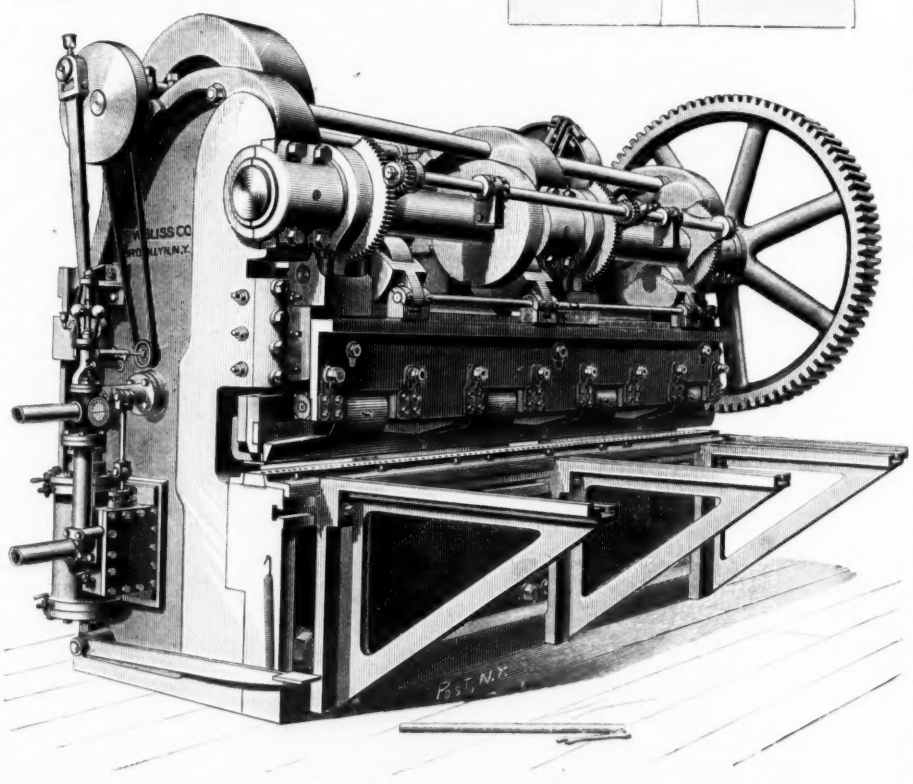
Our illustration is of a punching machine intended especially for punching a large number of holes at one stroke, the illustration showing it as arranged for punching 150 holes ¼″ diameter through iron ¼″ thick.

The vertical engine at the left gives motion to a crankshaft at the top of the machine, there being on this shaft a friction clutch, such as was illustrated in detail in our issue of July 13th. This clutch is thrown in and out by a foot treadle, and gives the operator complete control of the machine. When the crankshaft has made one revolution, a cam throws out the friction clutch, and applies a brake, thus stopping the machine at the highest point. This device obviates entirely the difficulties experienced with positive automatic clutches on heavy geared presses.

The adjustment of the slide is effected by means of an eccentric disk interposed between the crank-pin and the pitman, which eccentric disk is actuated by means of the pinion shaft shown in front of the main shaft in the cut, this shaft being turned by hand by means of a ratchet which is permanently attached to it, as shown.

Another special feature in this machine is the cam actuated stripper. This stripper is actuated by two cams on the crankshaft which cause it to descend before the punches, holding the sheet and straightening it during the punching action. The section of the slide and die plainly shows the construction of this stripper. The main advantage of this stripper is that it permits of using shorter and consequently stiffer punches. By making the front portion of this stripper in sections as shown in the cut, it is possible to renew easily punches which have been bent or broken. As will be seen from the sectional sketch these portions of the stripper are hinged and can be swung forward easily.

The principal dimensions of the press are as follows: Length of table, 154″; width of table, 12″; length of slide, 154″; stroke, 2″; diameter of shaft, 8″; diameter of eccentric, 10″; back gearing, 1″ to 28″; total weight, about 60,000 pounds. It is made by the E. W. Bliss Co., Brooklyn, N. Y.



ENGINE DRIVEN GANG PUNCHING MACHINE.

Picked Up in the Shop—Some Kinks for Wood-workers.

BY FRED H. COLVIN.

When we see the many toys, mostly of wood, that are displayed around the holiday season, we do not realize the important part they play in the wood-working industry of the country; a visit through one of the large shops where these toys are made will do more to impress it on the mind than all the figures that can be arrayed to prove the assertion. As this is not an advertisement for the firm in question, it will suffice to say that they consume about 40,000 feet of lumber per month in the manufacture of toys; when we consider this is only one of several, the amount of lumber used for this purpose is something enormous. As the foreman remarked, "Two or three weeks after Christmas you can't find ten per cent. of them whole; seems like wasting good lumber," but it gives employment to many people, and amuses the coming men and women. A visit disclosed many kinks that ought to be useful in many other places, so I will give a few of them, hoping they will be of service to some of the readers.

Much of the work in a place of this kind is necessarily boring, and the vertical boring machines have the preference for many reasons—ease of holding work, seeing just where the drill or auger is cutting, and several other reasons, not that the horizontal machines are not useful, but for this work they do not seem so well adapted.

One of the troubles with the vertical machines, however, is the nuisance of the chips getting on the work and covering the marks or guides; a man should always see what he is doing, if possible. To overcome this difficulty an ingenious little fan was rigged as shown in the cut (page 2). It is simply a wooden center or spool, *A*, with a diagonal cut made each side to receive the wings *W W*, which are merely leather flaps; any leather will answer, providing it has enough stiffness to stand out when at work.

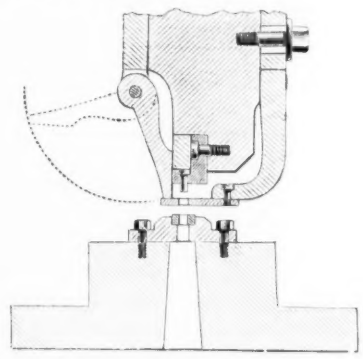
Care should be taken to cut the side slots at the right angle, so as to throw the air down instead of up, thus clearing the work in good shape.

These fans are made by the dozen, and kept in stock, one for each size drill; when in use they are slipped over the drill point upon the shank as far as necessary, and they run by friction, making a cheap and effective device, which, with several others I shall show, are due to the ingenuity of Mr. Leslie F. Burpee, the young assistant foreman in the shop in question.

In a place of this kind the sharpening of the bits becomes quite an item in the work, and believing that a man can work faster and better in the light than where the light is weak or shadowed, the young man before mentioned put up the frame shown in the cuts, Fig. 2. This is fastened to the partition beside a window where the light is uninterrupted and at a convenient height, so that stooping to file the bit is no longer necessary. This work is usually done on the bench, and the difference between the two ways must be tried to be appreciated.

It is often difficult, especially in a small place to get bits of the required size at a moment's notice, while the ordinary sizes of drills can be had much more readily.

This being the case, it is often necessary to use drills in place of bits, and the first thing on the programme is to make bits of the drills; this is done by filing.



We all know that the drills as sold are tempered much too hard to be filed, and it was the manner of drawing the temper on them in this place that attracted my attention. Fire is not a good thing to have around a wood-working shop, and yet the business hardly warrants a separate place for the forge or tempering arrangement, so they take a piece of hard wood, and by forcing the drill (while revolving) into the wood at a rapid rate, it is heated enough to draw the temper just where they want it—a blue, hard enough for a bit, and fairly easy to file.

The method struck me as being quite ingenious.

After seeing the large and elaborate "quartering machines" used for quartering driving wheels in locomotive practice, the one in use here for much of the work seems simplicity itself. Fig. 3 gives the general idea; the body is cut to receive the piece to be drilled, and the first hole drilled from the top, a quarter turn brings the drilled hole to the pin shown which forms the stop while the next hole is being drilled, and the operation continues at a rapid rate.

The same idea can be used for any number of holes, and the rig being exceedingly cheap can be used in a variety of forms.

Great attention was paid to the guarding of belts in this shop; all of them that ran through the floor were boxed up to a height of five or six feet, so high that any one would have to try very hard indeed to get caught in them.

This is too often neglected, and damages do not compensate for a crippled arm or leg. Better take a little precaution; it is more humane and morally right, regardless of the dogmas or doctrines of the proprietor.

It is a workman's right to demand proper protection from accident, and how the owners of some establishments that are regular death traps can sleep comfortably or enjoy a moment of life, is more than I can see.

In many wood-working shops, in fact in all that had the shafting above the floor (and with a two or more story shop some of it must be), I have noticed the accumulation of dust to an astonishing degree; in fact, have been deceived in the pulleys, and thought they were wood, when in reality they were iron, so filled as to resemble the wooden pulley of commerce.

This coating is often two and three inches thick, and must vary more or less in weight and thickness on the different sides of the pulleys.

The question that comes to mind is, Does this not affect the balance of the pulleys, and through them the running of the shaft? It seems plain that it must; how much is another question, and one quite hard to determine.

But when we consider that so much of the power of the motor driving the plant is consumed in the shafting alone, leaving oftentimes less than half (in a large shop) available for useful work, these little holes where the power can creep out must be looked after. Allowing one-half the engine power for the shafting, and deducting the friction of the machinery itself, the useful power seems far too small to be needlessly wasted, the percentage available approaches the frictional cards of some of the engines used in cable railways.

In the cases where power is rented, as it usually is, without any accurate means of knowing the power consumed, it seems reasonable to assume that it would be to the interest of the party furnishing power to look after all the shafting connected with his engine.

This may seem like a remedy that is worse than the disease, but in a large plant where the power is much subdivided, the condition of some of the shafting is scandalous. It suits the tenants as long as it stays in the hangers and does not heat very badly; the fact of its attempt to imitate a corkscrew at every revolution does not affect them in the least, but it does affect the coal pile.

It does not cost much to keep shafting in line and well cared for; the tenants would be glad to be relieved of the care of oiling it, and it seems as though it ought to result in a saving to the party furnishing the power.

To return to the woodwork. When it comes to drilling small stock, in the end it

is a nice job to get the drill to go somewhere near the center, *i. e.*, by some of the methods used. Here, however, I saw a lot of small stuff, probably about quarter-inch rods, being drilled as easily as any other work, and as near true as desirable. This time it was a horizontal boring machine that did the work. A board was fixed in front of the drill chuck as shown in Fig. 4, and the hole through the board was of the right size to just allow the stock to pass freely, and the guide was long enough to keep it straight. By adjusting this so as to come central, the stock could be fed through this hole to the drill, and removed very quickly, making a cheap and effective rig for the work.

Among the many other devices that facilitated the work were numerous forms and frames that at first sight seemed superfluous, but when we think of the immense numbers of the articles made, their use becomes apparent. I refer to the extensive use of forms for putting work together.

Instead of hammering it together, as we would do if we were making a single piece, they use forms that just inclose the article to be pressed, and by a cam movement the sides are brought together, making the pressure as nearly uniform as possible, and doing a much better job than hammering can do.

This is applied very extensively to all glued work; after being coated with the glue, the pieces are pressed into place and laid aside to dry, making a good joint.

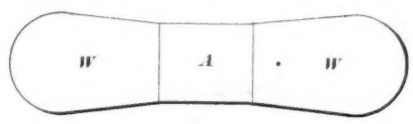


Fig. 1

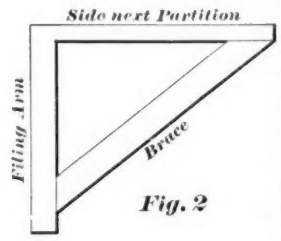


Fig. 2

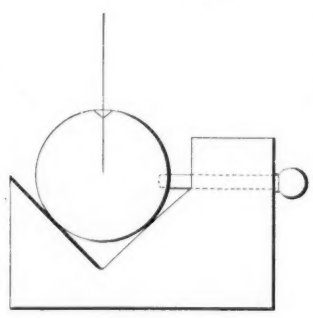


Fig. 3

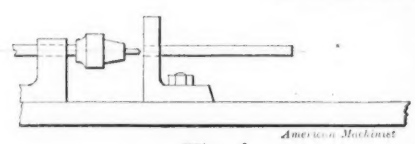


Fig. 4

PICKED UP IN THE SHOP.—(See page 1.)

Theory of Steam Engine Governors—II.

BY J. BEGTRUP.

Some inaccurate and misleading statements have inadvertently slipped into my article of October 19th. Namely in the formulas for gravity governors appears the following:

For $Q = o$ we have $n = \sqrt{\frac{1}{.102\ c\ h}}$;

it should be $n = \sqrt{\frac{1}{.102\ h}}$;

and in the paragraph on an eccentric with variable throw the centrifugal force of the eccentric should be subtracted from the centrifugal force of the balls, not added, as I have it. The diagram would then appear as shown here in Fig. 10 where the same notation is used as before.

The motion of a fly-weight can best be understood by reference to a shaft governor. In Fig. 11 A is the center of rotation of the governor, and the fly-weight, which we will suppose to be in the shape of a ball, moves on a radial line between a and b. When the ball is at a it holds the eccentric in such a position that just enough steam is admitted in the cylinder to run the engine without load, and when the ball is at b it will admit sufficient steam to run the engine with its maximum load, and with about half the load on the ball will be in the middle position and admit enough steam to run the engine at its proper speed.

First assume the speed of the governor to be *invariable* and let the slanting line $A\ b_1$ be the line of centrifugal force, that is, ordinates to this line measured by the proper scale will give the magnitude of centrifugal force for any position of the ball. This line may in the same sense be the line of resistance of the spring, or more correctly the line of centripetal force, for it is a force capable of producing motion in one direction just as centrifugal force may produce motion in the opposite direction. In this special case we assume both forces to be exactly alike in magnitude for any position of the ball, which therefore being under the action of two equal and opposite forces will be in equilibrium wherever we put it between a and b.

But let us change the spring so as to make $e\ g$ the line of centripetal force; the ball will then be in equilibrium at o only, for to the left from o there will be an excess of centrifugal force while to the right there will be an excess of centripetal force.

Therefore if the ball be moved from its position of equilibrium at o it will come under the action of an unbalanced force represented by the shaded triangles, or, more correctly, by that part of the consecutive ordinates which is cut off between the sides of these triangles. Wherever we place the ball outside o it will be acted on by an unbalanced force tending toward o and the magnitude of such force is proportional to the distance from o. Now we perceive that if the ball be placed at a it will be carried back toward o with increasing velocity, and after reaching o it will continue its motion on the other side of o, but with decreasing velocity, and assuming no friction or other resistance it will finally stop at b but immediately commence to move back toward a and thus continue oscillating between a and b. While the ball moves from one extreme position to the other and back again it is said to make one oscillation, and a single movement between two stops, as from a to b, is called one-half oscillation. The kinetic energy stored in the ball by unbalanced centrifugal force will first then be absorbed by unbalanced centripetal force when it has reached the position b, for force multiplied by distance is a measure for kinetic energy, and this product is here represented by the shaded triangles, and if we call the left-hand triangle positive the right-hand triangle becomes negative, for the force is here acting in the opposite direction. At a and b therefore there is no kinetic energy, the ball is at rest for a moment, but on account of the potential energy stored in it by the resisting force it will immediately commence to move in the opposite direction. We have an example of such oscillation in the regulator of a watch, also in the ordinary pendulum, for if the oscillations of the pendulum be small we may without appreciable error represent the active force by triangles as in Fig. 11. Such force is called a reciprocating force.

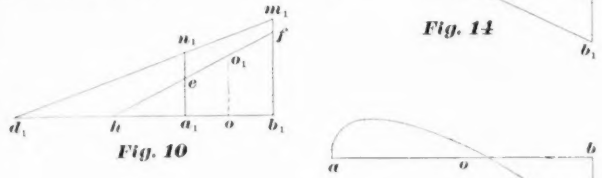


Fig. 14

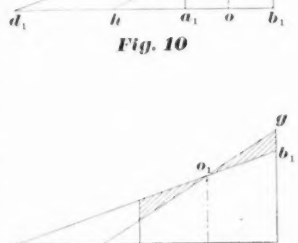


Fig. 10

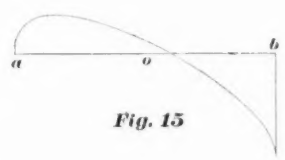


Fig. 15

Fig. 11

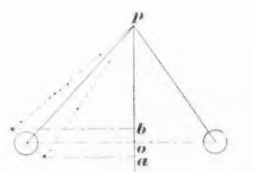


Fig. 16

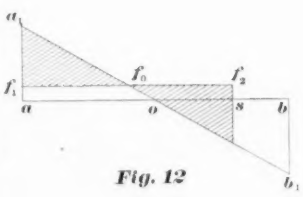


Fig. 12

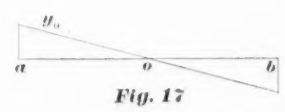


Fig. 17

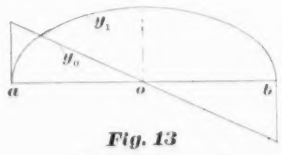


Fig. 13

Fig. 18

THEORY OF STEAM ENGINE GOVERNORS.

As it is only the unbalanced force which produces motion we may draw another diagram representing the reciprocating force only. Thus in Fig. 12 $a\ b$ is the line of motion, being also the line of reference. I shall call it the base line as a more significant expression in our case, and the slanting line $a_1\ b_1$ is the line of unbalanced force positive to the left from o and negative to the right, forming two triangles corresponding to the shaded triangles in Fig. 11 but on a different base line. We have assumed no friction which is a practically impossible condition; let us therefore first investigate the effect of friction under the assumed conditions. Friction is a resistance; it can produce no motion; it is an energy-destroying agent, for although energy cannot be destroyed according to a well-established physical law, it will in our case transform kinetic energy into heat, etc., which is lost so far as the governor is concerned.

Friction can be represented graphically as a resisting force which *always* acts against the motion; thus in Fig. 12 let $f_1\ f_2$ be the line of friction representing a uniform resistance of magnitude $a\ f_1$; the rectangle $a\ f_1\ s\ f_2$ will then represent the amount of energy consumed by friction while the ball moves from a to s, it will subtract from the positive triangle and add to the negative triangle leaving the resultant energy as represented by the shaded triangles positive to the left from f_0 and negative to the right, $f_1\ f_2$ being now the baseline. If the ball starts from a it will stop at s, for at that point the shaded triangles are equal, and it is easy to see that for each half oscillation the amplitude or amount of motion will diminish a distance equal to $s\ b$ and the ball will therefore come to rest after a certain number of oscillations depending on the amount of frictional resistance. The time of one oscillation is called the period or the time of the oscillation. The oscillation here considered is of equal period, for the time is independent of amplitude and friction; it is determined by the inclination of the line $a_1\ b_1$ only. This theorem will be found in a little different form in textbooks on dynamics, but the following expression is most convenient for our purpose

$$t = \frac{\pi}{\sqrt{a\,\frac{h}{s}}},$$

where t = time of one-half oscillation, a = acceleration of the ball for unit of force, and $\frac{h}{s}$ = height of triangle divided by base or the trigonometrical tangent of the angle of inclination. Seconds, inches and pounds should be chosen for units here and a means the increase in velocity of the ball by an unbalanced force of one pound in the direction of motion.

The reciprocating force here considered can only exist in a non-isochronous governor, for when we approach to isochronism the angle of inclination of line $a_1\ b_1$ becomes smaller and would disappear by perfect isochronism, that is, there would be no reciprocating force. I will for further reference call the reciprocating force here considered y_0. We have assumed the speed of the governor to be invariable; this cannot be so if it is attached to the engine shaft, for by the motion of the ball on both sides of its position of equilibrium more or less steam will be admitted in the cylinder, and the speed of engine and governor will vary accordingly, and a direct consequence of this will be a corresponding variation in centrifugal force.

We have in the former case considered variations in centrifugal and centripetal force due to variations in the position of the ball in relation to the center of rotation. We will now consider variations in centrifugal force due to variations in rotative speed. As centrifugal and centripetal force balance each other by a certain rotative speed only it follows that by any variation from this speed there will be some force left unbalanced which will have a dynamic effect on the ball. We will suppose that any change in the position of the ball will cause an immediate change in the driving power, which would not be true for an automatic cut-off engine, but very nearly so if steam admission was controlled by a throttling governor. It will, of course, be understood that the primary cause of any oscillation is, or rather should be, a change of load or steam pressure, and a consequent variation in speed; but it is not difficult to comprehend that when once the condition of equilibrium is changed the motion will be as here described, for the only condition here imposed is that the ball shall not be in equilibrium, and we assume this condition to be fulfilled by moving it away from its position of equilibrium, while in reality the position of equilibrium is moved away from the ball, which amounts to the same as far as the oscillation is concerned, and the condition of stability in any governor must, of course, be such that the ball shall return to its position of equilibrium if it by any action whatever is moved away from it.

The engine is supposed to be about half loaded, and o, Fig. 13, is the position where the ball should be at rest in order to admit the proper amount of steam, but let it be moved from this position of equilibrium to a point a, it will then, as we have seen, oscillate for some time on both sides of o under the action of a reciprocating force y_0. Taking o as a starting point then, it is obvious that while the ball moves from o toward a and back to o more steam will be admitted than required, and the speed of the engine will consequently increase during that period, but while the ball moves from o toward b and back to o there will be a deficiency in steam and the speed will be retarded. Therefore when the ball passes o from the left we have maximum rotative speed, and when it passes o from the right we have minimum rotative speed, and mean speed will consequently occur at the two extreme positions, for instance at a and b.

Therefore while the ball moves from left to right the rotative speed will be in excess of mean speed, and while it moves from right to left the speed will be below mean speed. We will consider one movement from a to b ignoring friction. The increase of rotative speed from mean speed during this period will cause a corresponding increase in centrifugal force, and the effect will be an acceleration of the motion, there will be an increase of kinetic energy; it is therefore obvious that the ball would move beyond the position b unless there be sufficient friction to consume all this extra energy; that is, a certain amount of friction is necessary, for without this every succeeding

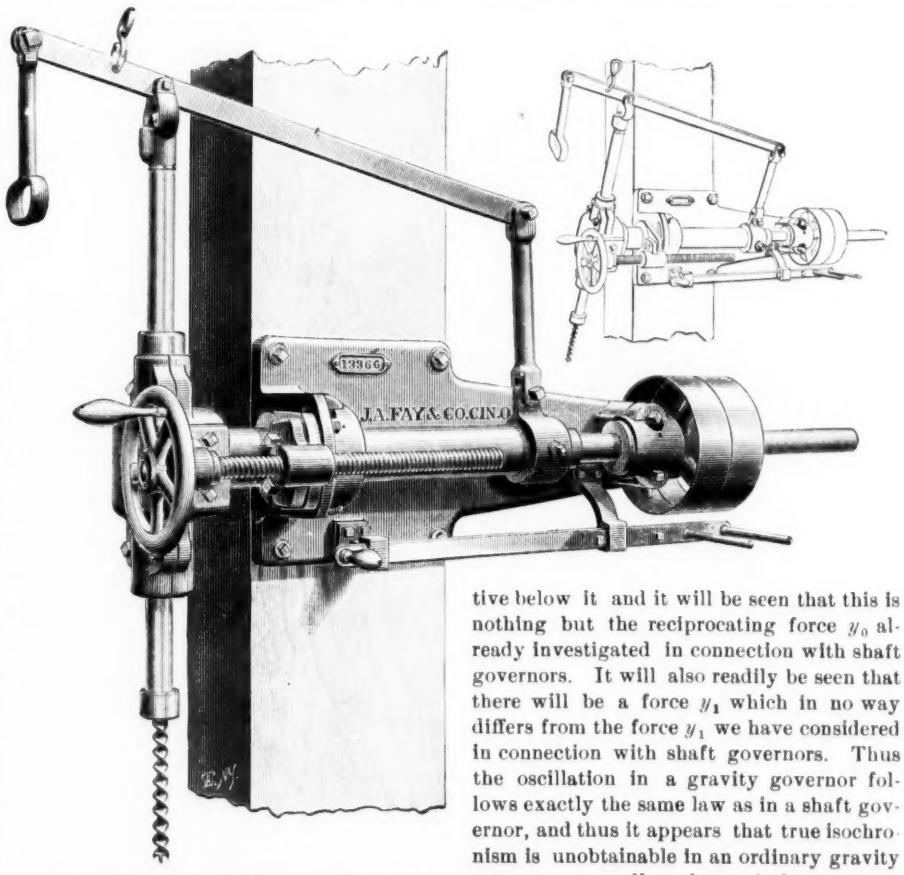
half oscillation would be greater than the next preceding one, the governor would be "racing." To obtain a clear conception of this increase in centrifugal force during one-half oscillation we may represent it graphically by a curve. Let the excess of centrifugal force be denoted by the symbol y_1, and let it first be assumed that there is no friction, and that the force y_1 has no dynamic effect on the ball, we shall then obtain the curve shown in Fig. 13. At a the ratio of increase in rotative speed will evidently be greatest, and as the ball is just starting from momentary rest we perceive that the tangent to the curve must be perpendicular here; at o the increase in rotative speed has reached its maximum, and we have therefore the highest point of the curve here; at b the rotative speed will be rapidly decreasing while the ball approaches a point of momentary rest, and the curve will therefore terminate vertically here. We may from this infer that the curve must be a half ellipse which in fact it will be, if we do not take into account a slight irregularity caused by variation of the radius of rotation of the ball. This would then be the curve of force y_1 if it had no dynamic effect; that is, if the oscillation was controlled by the reciprocating force y_0 only. In reality force y_1 would accelerate the motion causing an oscillation of increasing amplitude, and the shape of the curve would be changed by a frictional resistance, but we perceive without closer investigation that the whole energy of force y_1 must be destroyed and also part of the energy of force y_0 if the oscillation shall be decreasing and the ball finally come to rest at o.

As the force y_1 is the result of an increase of rotative speed, and as such increase must be in inverse proportion to the moment of inertia of the fly-wheel, it becomes evident that force y_1 will be reduced by increasing the weight or size of fly-wheel and then less friction will be required for the absorption of the energy of this force, but it is also evident that the quicker the motion of the ball the smaller the fluctuation in speed and the smaller the amount of energy accumulated by force y_1, and that therefore also in this case less friction is required, or else by a quicker motion of the ball we might reduce the fly-wheel.

I shall now show that it is only a certain amount of energy which can be consumed by friction, and the inertia of fly-wheel and degree of isochronism must be such that this amount shall not be exceeded, for otherwise we have no means of destroying it. In Fig. 14 we have a slanting line for force y_0, a parallel line for friction and a curved line for force y_1; friction is assumed equal in magnitude to force y_0 at a, and the line y_1 is correctly drawn as it will appear in this case if the oscillation shall be neither increasing nor decreasing, that is, $a\,o = o\,b$. In the following the investigation will always rest on this assumption, for it being the limiting condition of stability any change in the governor or engine which reduces the effect of y_1 at all will then give a decreasing oscillation. Now remembering that force y_0 is positive above and negative below the base line, and force y_1, being above the base line, is entirely positive, and that friction although above the base line is always to be regarded as a negative force, we may by addition and subtraction obtain a series of resultant ordinates and thus construct the curve shown in Fig. 15, which then is the resultant force curve for one half oscillation. The areas above and below the base line represent the work of acceleration and retardation, or else positive and negative kinetic energy, and must therefore be equal, and it will be seen that the resultant force has some similarity to force y_0, but while the force y_0 is greatest at a there is an equal amount of frictional resistance, and the resultant force is therefore nothing at that point. In Fig. 14 the two areas y_0 are equal, and we must therefore also have area of friction equal to area y_1, and the moment of inertia of fly-wheel is supposed to be such that this result will be obtained; but suppose we had a lighter or smaller fly-wheel, then area y_1 would be greater and more friction would be required to destroy this extra energy; but if we increase the friction it will exceed the initial value of y_0 at a, and no motion would take place before the speed and consequently force y_1 had increased sufficiently to overcome this extra friction, there would therefore be a period of rest at a, and the curve y_1 would rise vertically till motion commenced, but the curve would otherwise be the same as if there had been no period of rest. Let $a\ e$ represent the amount of friction required, then the curve y_1 would rise vertically a distance $a_1\ e$ before any motion could take place, and the increase of energy on this account would be represented by rectangle a_1, e, h, g, but this would just be the extra area of friction and the result would therefore be the same as if there had been no increase of friction. That is to say, for an oscillation of amplitude $a\ b$ all frictional resistance greater than the force y_0 at a will in no way reduce the oscillation. If therefore the inertia of fly-wheel is not sufficient to keep such oscillation within its proper limits any additional friction would be ineffective as an energy-destroying agent.

As the angle of inclination of the line y_0 becomes smaller as we approach to isochronism it follows that a smaller part of the friction will then be useful for the absorption of energy, and from the formula for time of oscillation of force y_0 we infer that the time will also be increased when we approach a state of isochronism and the result is less stability, which means that the ball will make a greater number of oscillations before it comes to rest at the position of equilibrium or that the governor will "race" or else that any unfavorable and unforeseen circumstance will set it racing, and as there, in a truly isochronous governor, would be no friction available for the absorption of energy we see that true isochronism cannot obtain in the ordinary centrifugal governor—a fact fully confirmed by experience.

As the oscillations become smaller y_0 will also become smaller in the same proportion, therefore if we have friction equal to the initial value of y_0 for a large oscillation we shall have an excess of friction for a smaller oscillation, and as any desired amount of frictional resistance can be furnished by a dash pot for the larger oscillation we shall in the following always assume an excess of friction. We have, therefore, a period of rest for each half oscillation and an energy destroying resistance equal to the initial valve of y_0 whatever that may be. It can be shown that the force y_1 is directly proportional to the amplitude, and that the oscillation will be of equal period if we do not count intervals of rest. The curves for different amplitudes will therefore be similar, and we may in our investigation assume oscillations of any proportion, for the results will be generally true. In a gravity governor the ball moves in a small arc which may be considered as a straight line inclined toward the spindle; we may resolve this oblique motion in a vertical and horizontal motion, and if we consider the vertical motion we obtain a vertical oscillation which, of course, follows the same law as the oblique oscillation. In Fig. 16 let $a\ b$ be the vertical motion of the ball which is shown in its position of equilibrium; then if the speed remains unchanged we have $a\ p$ and $b\ p$ representing vertical components of centrifugal force for the lower and upper position respectively, and $o\ p$ for the middle position, and as the opposing force is the weight of the ball which remains equal to $o\ p$ we have an unbalanced force at a represented by $a\ o$, and at b an unbalanced force represented by $b\ o$ acting in the opposite direction, and for any other position of the ball the unbalanced force will be proportional to the vertical distance from o. We can now draw a horizontal diagram as in Fig. 17 where $a\ b$ represents the vertical motion and the slanting line is the line of unbalanced force positive above the base line and negative below it and it will be seen that this is nothing but the reciprocating force y_0 already investigated in connection with shaft governors. It will also readily be seen that there will be a force y_1 which in no way differs from the force y_1 we have considered in connection with shaft governors. Thus the oscillation in a gravity governor follows exactly the same law as in a shaft governor, and thus it appears that true isochronism is unobtainable in an ordinary gravity governor as well as in a shaft governor. The oscillatory motion of the balls of a Watt's governor by a considerable and sudden change of load is plainly visible. If we want to represent it graphically we must show the oscillation in decreasing geometrical progression as the zig-zag line in Fig. 18 where the position of equilibrium is represented by the center line $o\ o$. The nature of the motion of the governor weights have now been explained. I have been somewhat explicit in my demonstration for a clear underatsanding of this matter is necessary as a foundation for any further investigation. If the underlying principles are fully understood it will appear that many ingenious contrivances which have been applied to governors are of little, if any, account, and that in the designing of governors too much ingenuity is sometimes a hindrance to success. In my next article I shall explain the effect of inertia and friction of rest, etc., and arrive at some definite conclusions.



PORTABLE RADIAL BORING MACHINE.

Portable Radial Boring Machine.

We illustrate herewith a machine which is a valuable one for boring holes in timbers at any desired angle in light or heavy work.

In boring large timbers, that can be handled only with considerable effort, this machine is very desirable, as the boring spindle can be readily moved vertically or transversely, and can be set at any angle from the vertical.

The boring spindle is $1\frac{5}{16}$" diameter, has a vertical movement of 12", and an adjustment by a hand-wheel and screw across the face of the timber of 12". The gearing for driving same is encased in a housing, keeping it free from dirt. The depth of bore is regulated by a stop collar, above the housing on the vertical spindle.

The machine is self contained, the tight and loose pulleys being placed on the driving shaft, and a suitable belt shifter in position convenient to the operator. Four machine augers of assorted sizes are supplied with each machine. A table is not supplied, the purchasers making their own of any style or dimension that may suit their work.

The machine is made by J. A. Fay & Co., Cincinnati, Ohio.

"Upper Tuyere" Cupolas.

The following letter, which we publish in justice to the Detroit Foundry Equipment Company, of Detroit, Mich., explains itself:

NOVEMBER 18, 1893.

MR. THOS D. WEST,
Sharpsville, Pa.

DEAR SIR:—We have had much pleasure in reading the article you presented to the Western Foundrymen's Association at Chicago. The writer was unable to be present, but some of our representatives were, and were very much impressed with the article. The AMERICAN MACHINIST of November 2d has published practically the entire article. The great objection I see to the entire arrangement is the awkward feature of getting rid of the tuyere when you wish to drop the bottom, and also replacing the same the next day. Our experience in the cupola line has been, during the last twenty years, with "upper tuyeres." The writer had charge for twelve or fifteen years of the Detroit Car Wheel Company's foundries, and also the Detroit Pipe and Foundry Company's shops, as superintendent. We melted in the neighborhood of 300 to 350 tons of iron on an average per day, and made a great study of the care of the cupolas, and their melting powers.

On page 2 of the AMERICAN MACHINIST, fourth column, toward the top, the paragraph reads:

"Not only does this plan save fuel, but also the lining of cupolas, while the present methods of principles now used for accomplishing economy in fuel do so at a sacrifice to the lining; so much so as to make in many cases a question if there is any economy in using 'upper tuyeres.'"

We have records to show for several years back, of melting near on to 14,000 tons of pig iron and scrap, without re-lining, in one cupola, for use in car, locomotive, and miscellaneous castings, and the ratio of fuel to iron is ten to one. The iron is so hot that it can be used for stove plate. The arrangement of the tuyeres in the cupola also give great vitality and life to the iron. We can verify these statements in any manner that may be desired. The cupolas just at present are not being run to any great extent as business is very dull.

We find in selling cupolas, that people, as a rule, are looking for the cheapest lining possible, and we have also discovered in many instances that people fail to keep their cupolas in perfect shape and good melting order. We make this comparison from our own stand point and what we have seen of the inside of cupolas used by other people. Our greatest trouble in the management and operating of cupolas is to persuade people to unite our information with their own and draw the benefit from it.

Towards the end of the article we note your remarks about the saving of fuel, and you speak of using a 68-inch cupola, which we understand is the measurement inside of lining. In this cupola you use 3,000 pounds of coke on the bed. In our No. 9 cupola, which we recommend lined up to 66 inches, we use from 2,200 to 2,400 pounds of coke on the bed, and get perfectly satis-

factory results. We recognize about the most important feature of the cupola is the care which it receives, and we have tried to reduce this to the finest possible point, so as to get the best possible results from the "Whiting cupola."

In writing this we simply aim to get our position as manufacturers of "upper tuyere" cupolas somewhat protected from your criticism on the use of them, and if you are willing we will write this same letter to the AMERICAN MACHINIST and ask them to produce it, or copy a portion of it.

Kindly let us hear from you at an early date, and oblige,

Yours very respectfully,

J. H. WHITING,
President.

P. S.—Another point we might mention of "The Whiting" is, that the bottom drops and leaves the cupola in a very clean condition, similar to that you speak of, and there is very little work the next morning for the cupola man to do when he places the cupola in good shape again.

J. H. WHITING,
President.

Independent Condensers—The Worthington Condenser as Applied to a Stationary Engine.

During the past few years independent condensing apparatus for steam engines has grown rapidly in public favor, this growth keeping pace with the extension of a knowledge of its advantages and adaptability. Some of the advantages of this system as compared with the use of an air-pump driven direct from the main engine may be referred to. In the latter case, in the instance of stationary engines, the air-pump is driven at a constant speed, which must be great enough for the heaviest load, and the warmest condensing water liable to be used. As the greatest load is likely to be largely in excess of the normal, and the water in summer materially warmer than in winter, it follows that the air-pump must be larger than would be required during the greater part of the time, in order to provide for fair conditions at intervals, which means a waste of power for the greater portion of the time.

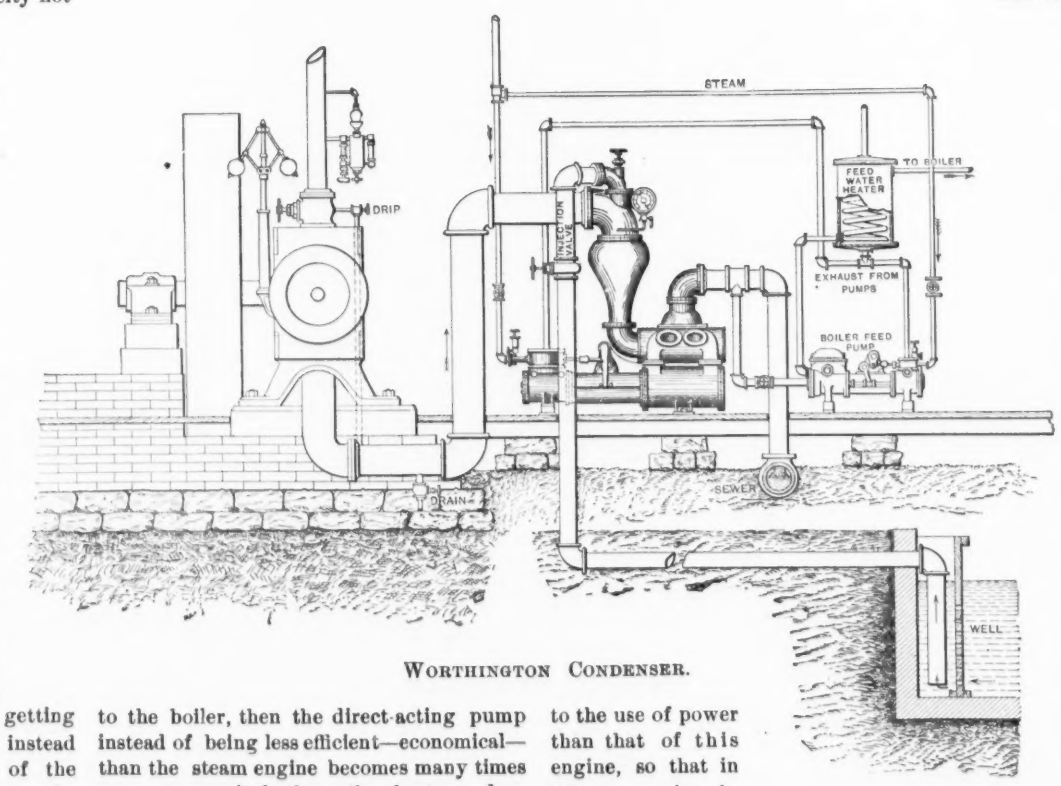
With the independent condensing apparatus there is the quality of elasticity not possessed by the engine-driven pump, as the speed may be varied to exactly suit the conditions as to power and temperature of injection water, this, of course, resulting in an average saving in the power required to do the work of producing a vacuum.

Another feature of some importance is in the instance of leaky stuffing boxes. Every engineer knows that there will sometimes develop a leak that cannot be remedied while the engine is in operation. With the air-pump driven from the main engine, the incidental loss of vacuum must be borne until such time as the matter can be attended to, while with the independent apparatus it is generally possible to increase the speed of the pump so as to quite, or very nearly, maintain the usual vacuum during this interval.

Another point in favor of the independent apparatus is that it can be put in operation before starting the main engine, thereby getting the benefit of the vacuum at once instead of waiting for the slow operation of the engine-driven air-pump. This is, generally speaking, of more importance in the instance of marine engines, and more desirable with compound than with simple engines, but in every instance it is, to say the least, a matter of convenience.

These are a few only of the claims that can be made for the independent system of condensation in which the air-pump piston is driven direct from the steam piston. It might further be said for it that it is simpler and more accessible, and that less power is absorbed in friction as well as that none of the power of the engine is absorbed in its operation.

In the use of a condenser, as in any detail of a steam plant, the economy of operation must be considered. In the direct-acting apparatus, to which reference is specially had, it is evident that the friction is reduced to a minimum, that is, it is materially less than with any form of engine-driven air-pump. This proposition is so plain as to require no argument. But as compared with an economical steam engine it is well known that a direct acting steam pump, using steam full stroke, is wasteful. The natural assumption then is that this uneconomical use of steam in the pump will, so far as the question of the cost of power to operate is concerned, more than overbalance any gain due to the direct application of power in the direct acting pump. This would be quite true were the exhaust into the atmosphere or into the condenser. But if the latent heat of the steam can, without cost, be returned to the boiler, then the direct-acting pump instead of being less efficient—economical—than the steam engine becomes many times more economical than the best modern steam engine, which utilizes, as is well known, but a very small fraction of the heat imparted to the water in the boiler.



WORTHINGTON CONDENSER.

The illustrations on this page show how this is accomplished in the use of the Worthington condenser. The half-tone engraving represents the condenser in its general appearance, and the other engraving illustrates its attachment to a stationary engine. It will be observed that there is no heater between the engine and condenser. The use of such a heater is not recommended except in instances where the water used for condensation is not suitable for use in the boiler, as the slight gain is believed to be more than overbalanced by other and apparent losses. A strainer is placed at the lower end of the injection pipe, the arrangement being such that it can be conveniently come at for inspection and cleaning.

The means for bringing about the great efficiency of the condenser pump may now be referred to. It will be observed that the exhaust from this pump passes through a small feed-water heater, through which also the exhaust from the feed pump passes. In this heater the latent heat of this exhaust steam is entirely utilized in heating the feed water to 160 or 170 degrees, so that this heat is returned to the boiler, as previously referred to. When it is remembered that the greater part of the heat in steam is known as latent heat, it will be readily understood how by this disposition of the heat the direct-acting pump of the condenser is made economical far beyond the main engine. For example, the main engine may, in the best practice, have a thermo dynamic efficiency of, say, 12 per cent., while that of the condenser may be more than 80 per cent. Of course, if the air pump is driven direct from the main engine its efficiency is no greater in regard to the use of power than that of this engine, so that in this the saving in favor of the independent system is enormous by proportion.

An advantage of the independent system not previously referred to is the facility it offers for converting non-condensing to condensing engines, resulting in an important saving in fuel and increase in capacity. The apparatus we have illustrated is made by Henry R. Worthington, 86 Liberty street, New York. The condenser proper, which possesses important features of construction, has been the subject of a previous illustration in these pages.

Electrically Driven Blowers.

With the increasing use of electricity it has been shown to be very advantageous in many cases to drive blowers by electric motors, usually direct connected as in the case of the machine illustratedon page 5, whose builders, the Buffalo Forge Company, of Buffalo, N. Y., have adapted motors to several sizes and varieties of their machines, among them the one illustrated, which is designated by them as the "B" volume type of exhauster and blower.

With such a blower to start and stop is simply a matter of moving a switch or pushing a button, according to the arrangement; no engines or belts are required, and the blowers are always ready for immediate use.

One special feature of their great convenience, to which particular attention is called, is the fact that the fans can be set up in any position without affecting the running of the motor. This so adapts the fans that they may be located to discharge or exhaust from any desired direction which entails least complication of pipe connection. The machine illustrated when built as an electric fan can readily be furnished in all the different styles of discharges.

All types of fans built by the above-named house can be readily fitted and furnished with direct attached electric motors, though in the case of very large steel plate fans, it is usually more desirable to employ an independent motor, conveniently located, and then belt to the fan. All the fans supplied are of standard high grade, but are somewhat especially designed to receive the motors. That the highest efficiency may be secured, electric motors of approved design and special construction are built for the different varieties of fans. They are capable of continuous use with only ordinary attention.

For ventilating work these fans have found wide favor, and may be employed in a multitude of positions where the introduction of an engine and boiler for driving would be impracticable. All that is required is a wire connection with a power circuit, and the fan is ready for immediate operation. Electric fans may be driven at a high speed, therefore they are of relatively large capacity. The combination of electric motor and fan, with proper care and under ordinary conditions of use, is noiseless in operation, and is, of course, the acme of convenience.

With very large cupola or volume blowers, where a direct combination is desired, it is frequently advisable, to maintain a low motor speed, to connect the motor direct to a countershaft and belt from same to the pulleys on fan with a short connection, the whole being on a bed-plate with tightening screws for regulating the tension of belts. By properly proportioning the pulleys on countershaft, any air pressure required for ordinary duty can be given while the motor is making its regular speed. Where a blower with motor attached to the blast wheel shaft is wanted for high speeds, the motor is invariably built to order.

For blowing church organs such electrically driven fans have been found admirably adapted, being entirely free from the well-known objectionable features and inconveniences of other forms of power employed for this purpose. The machine is under positive and complete control of the organist. In fact for all kinds of fans, including those which are part of heating and ventilating systems, this method of driving is proving an excellent one.

The Vermont State building has been sold to a Chicago plumber for $100; cost, $15,000.

Compound Air Compression.

BY FRANK RICHARDS.

I offer here a set of cards, scale 40, from the air cylinders of a compound air compressor. The cylinders of this compressor were arranged tandem, each single acting and doing their work upon the alternate strokes. The cylinders were 20″ and 11¾″ diameter respectively and the stroke 18″. The capacity ratio of the two cylinders was .345. Cards were taken from both cylinders when compressing to 35 lbs., to 40 lbs., and then by intervals of 10 pounds all the way up to 120 lbs. The cards presented are sufficient to bring out the peculiarities of the case. Card *A* is from the first or low-pressure cylinder. This card was the same throughout the whole series from 35 to 120 lbs., and it would have continued the same no matter how high the terminal pressure of the second cylinder were carried. A tracing was made of one of these cards and tried upon others of the series, and the variation was so slight as to be scarcely discoverable.

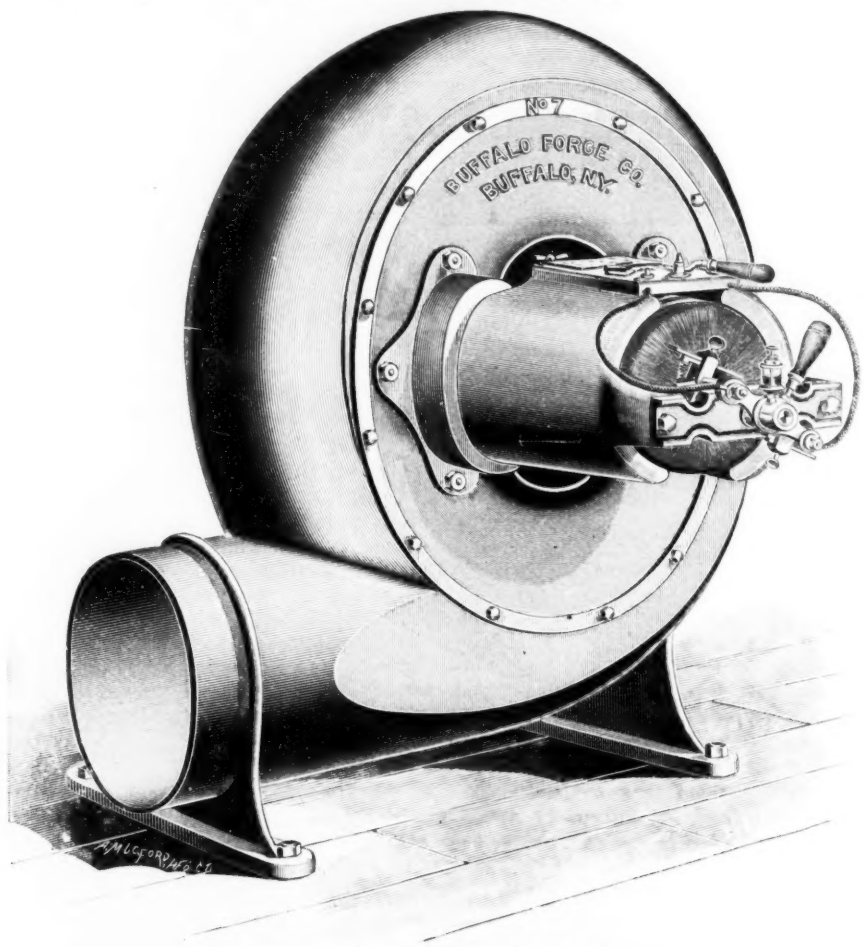
The mean effective pressure of this card is 15.8 and the terminal pressure is 35. While the terminal pressure is 35 lbs. it does not mean that if the compound compressor were compressing and delivering air at 35 lbs. pressure this first cylinder would be doing all the work of the compressor. It is to be remembered that the whole work of air compression comprises two distinct operations: the compression of the air to the required pressure, and the expulsion or delivery of the compressed air against practically the same pressure in the pipes or the air receiver. The first cylinder, in the case we are now considering, when the compressor is working at 35 lbs., happens to just do all the work of compression and none of the work of delivery. In any compound compression if either cylinder is to be called distinctively the "compression" cylinder that term always belongs to the first cylinder rather than to the second. If our compressor were working at a pressure higher than 35 lbs. the first cylinder would do but a part of the compression and, of course, none of the delivery. The work of the second cylinder when delivering air at 35 lbs. is shown by card *B* taken from that cylinder.

The mean effective pressure for the two operations of air compression are never the same whatever the working pressure. The mean effective pressure for compression only is always lower than the mean effective pressure for the whole work. The tables given in the AMERICAN MACHINIST, March 23d, of the mean effective pressure for the whole stroke, when all the work of compression is done in a single cylinder, are convenient for computations under those conditions, but they do not apply to compound compression. In addition to the table of March 23d I offer a table of the mean effective pressure for the compression part only of the stroke of a single air cylinder.

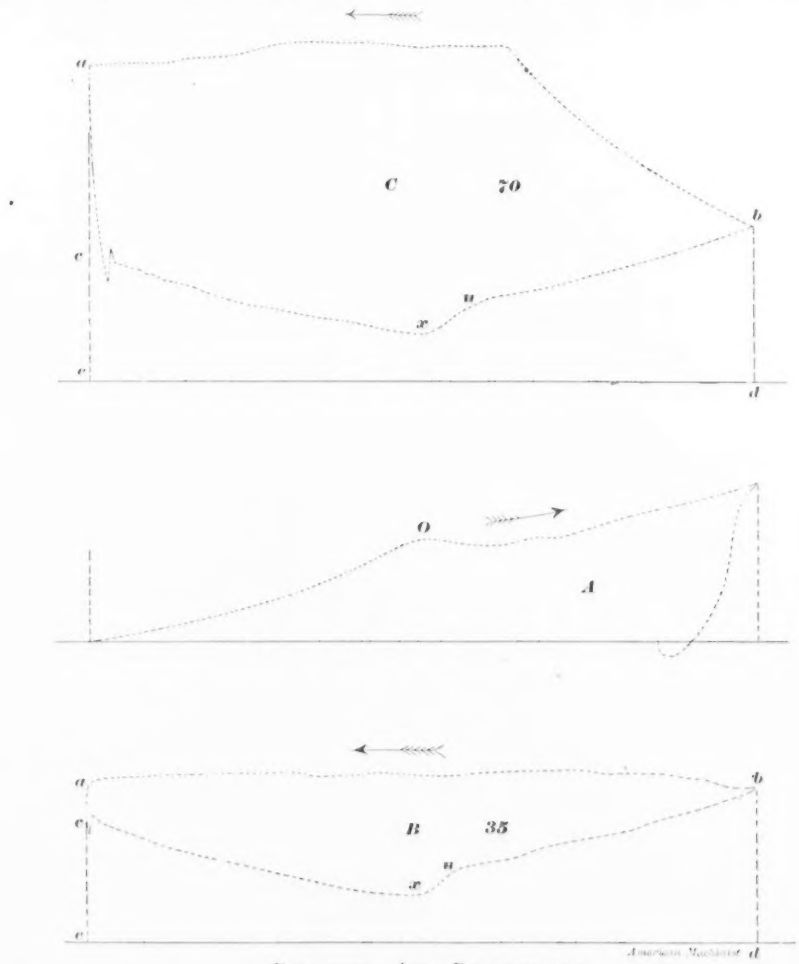
TABLE OF MEAN EFFECTIVE PRESSURES FOR THE COMPRESSION PART ONLY OF THE STROKE WHEN COMPRESSING AND DELIVERING AIR FROM ONE ATMOSPHERE TO GIVEN GAUGE PRESSURE IN A SINGLE CYLINDER:

Gauge Pressure.	Adiabatic Compression.	Isothermal Compression.
1	.44	.43
2	.96	.95
3	1.41	1.4
4	1.86	1.84
5	2.26	2.22
10	4.26	4.14
15	5.99	5.77
20	7.58	7.2
25	9.05	8.49
30	10.39	9.66
35	11.59	10.72
40	12.8	11.7
45	13.95	12.62
50	15.05	13.48
55	15.98	14.3
60	16.89	15.05
65	17.88	15.76
70	18.74	16.43
75	19.54	17.09
80	20.5	17.7
85	21.22	18.3
90	22.	18.87
95	22.77	19.4
100	23.43	19.92

Resuming now our compound compression, and referring again to card *A*, we notice that its mean effective pressure is greater than that given in the above table for compression only in a single cylinder. The table, as we said, has nothing to do with this case, but the comparison of figures might provoke a suspicion that we were here doing the same work at a greater expense. But the case represented is different in more than one particular. We are not here doing the work in a single cylinder, although we begin it there. For the latter part of the stroke the whole body of air then undergoing compression consists not only of the contents of the first cylinder that have not been expelled by the advancing piston but also of the entire contents of the passage connecting the two cylinders, and of that part of the second cylinder, constantly increasing, which has been left empty by its retreating piston. Neither is the compression confined entirely to the original contents of the single cylinder. While the compression begins with the contents of the larger cylinder, and the compression goes on in the larger cylinder alone for a time, when the point *o* is reached near the middle of the stroke communication is opened with the air passage and through it with the second cylinder. When the previous stroke ended the passage was filled with air compressed to 35 lbs., and at the end of the stroke this passage was shut off from communication with either cylinder, and it remained shut off during the whole of the return stroke, while the larger cylinder was being filled with the inrushing air, and while the air in the smaller cylinder was being expelled into the discharge pipe and the compressed air receiver. When the stroke has ended, and the compressed air is all expelled by the piston having reached the end of the smaller cylinder, the return stroke commences, and the air confined in the air passage begins to expand, and a part of it to flow into the smaller cylinder. The pressure is thus falling in the air passage by its connection with the smaller cylinder, and at the same time compression is going on in the larger cylinder, and the pressure in it is rising. At length a point *o* is reached where the pressure in the larger cylinder exceeds the pressure in the air passage and the smaller cylinder, and the air from the larger cylinder begins to flow into the air passage, and at the same time the contents of the passage and of the smaller cylinder become part of the body of air that is being compressed by the advancing piston of the larger cylinder, and until the end of the stroke the compression of the combined body of air goes on together.



ELECTRICALLY DRIVEN BLOWER.



COMPOUND AIR COMPRESSION.

The mean effective pressure for both compressing and expelling the air at 35 lbs., or the whole operation of air compression, so called, when performed adiabatically in a single cylinder is, theoretically, 21.6 lbs., varying somewhat as the air loses more or less of its heat during the operation. If we consider card *A* in connection with card *B*, they together represent the whole operation of air compression to 35 lbs., *A* representing the compression and *B* the delivery or expulsion of the air. The mean effective pressure of *A* is, as we have seen, 15.8, and that of *B* is 16.4. But it must be remembered that the diameters of the two cylinders are quite different, and 16.4 in the 11¾″ cylinder is only equal in power to 5.65 in the 20″ cylinder and $15.8 + 5.65 = 21.45$, the mean effective to be expected for the entire operation of compressing to 35 lbs.

While these cards were being taken, the compressor was run at about 80 revolutions throughout. At this speed the indicated horse power of card *A* is 18.05 and that of card *B* is 6.46, their sum being 24 51. Card *C* is from the smaller cylinder when compressing to 70 lbs. The mean effective pressure of this card being 43.4 and the indicated horse power being 17.1, the indicated horse power of card *A* being, as before, 18.05, their sum is 35.15. At 70 lbs. pressure it will be noticed that the horsepower of the two cylinders is nearly equal, and it would seem that the ratio of the cylinders to each other was approximately correct for such a pressure; but here another consideration comes in to upset the delightful symmetry. While the sum of the indicated horse-power as computed from the actual inclosed areas of the two cards is correct, as representing the total horsepower consumed, it does not correctly represent the actual distribution of the resistances as encountered in the opposite strokes of the engine.

This now calls our attention to the effect of the back pressure in the second cylinder as modifying the total resistance encountered in the alternate strokes. The back pressure line, as we have seen, starting at *c* represents the re expansion of the contents of the air passage. This re-expansion goes on in the small cylinder and the passage combined until the point *x* is reached, when the compression going on in the larger cylinder has brought its contents up to the same pressure. Then after a short interval, *x u*, occupied in securing a sufficient excess of pressure and in reversing the movement from expansion to compression, the compression continues from *u* to the end of the stroke, when the pressure of 35 lbs. is again reached. As the whole of the first card is always the same, no matter what the working pressure, so that it be not below 35 lbs., so the lower line of the card from the second cylinder is also always the same, and the only change in the pair of cards for different working pressures is in the upper line, or the compression and delivery line of the second cylinder. When compressing to 35 lbs. only, there is no compression in the high pressure cylinder, and its whole stroke is occupied in delivery. At the beginning of the stroke the resistance against the high-pressure piston is represented by the length of the vertical line *b d*. The resistance at any point of the stroke would be represented by a vertical line at that point drawn from the line *b a* down to the atmosphere line, and the total resistance for the working stroke is represented by the inclosed area, *b, d, e, a*. This means that the total

back pressure, b, d, e, c is to be added to or, rather, is not to be deducted from the work of the compression and delivery stroke of the high-pressure cylinder. During this working stroke of the high pressure cylinder, the low-pressure piston is making its return stroke, allowing its cylinder to refill with air at atmospheric pressure, and no resistance of any magnitude is to be taken into account as increasing or diminishing the total work of the high-pressure cylinder. When, however, the low-pressure cylinder is doing its work of compression, it is assisted in its work by the return or back pressure of the high-pressure cylinder which acts upon the high-pressure piston in the same linear direction as the low-pressure piston is traveling. The back pressure, b, d, e, c, which is added to the work of the high-pressure cylinder as represented by its inclosed area $b\ a\ c$, is to be deducted from the work of the low-pressure cylinder as represented by its card.

If now we go over the series of cards, computing the indicated horse power of each, adding the indicated horse-power of the back pressure to the indicated horse-power of each of the high-pressure cards and deducting the same from the indicated horse-power of the low-pressure card, as above described, we find that the net resistance for the alternate strokes is very inequitably distributed. The figures for compressing to 120 lbs. are also given to aid the comparison, although the card for that pressure is not shown. The case will stand like this :

Low-pressure cylinder, M. E. P. 15.8, I. H. P. 18.05.
Back pressure on each high-pressure cylinder, M. E. P. 20, I. H. P. 7.88.

Then 18.05 — 7.88 = 10.17, the net indicated horse-power for the compression stroke of the low-pressure cylinder.

High-pressure cylinder delivering air at 35 lbs. M. E. P. 16.4, I. H. P. 6.46.
High-pressure cylinder delivering air at 70 lbs. M. E. P. 43.4, I. H. P. 17.1.
High-pressure cylinder delivering air at 120 lbs. M. E. P. 65.7, I. H. P. 25.89.

Then

$$6.46 + 7.88 = 14.34$$
$$17.1 + 7.88 = 24.98$$
$$25.89 + 7.88 = 33.77$$

Thus even when compressing to but 35 lbs., the delivery stroke of the high-pressure cylinder takes nearly 1½ times the power required for the compression stroke of the low-pressure cylinder. When compressing to 70 lbs., the high-pressure stroke takes nearly 2½ times the power of the low-pressure stroke, and when compressing to 120 lbs., it takes more than three times as much.

The total power required for each pressure will be :

35 lbs. $10.17 + 14\ 34 = 24.51$
70 " $10.17 + 24.98 = 35.15$
120 " $10.17 + 33.77 = 43.94$

To this is to be added say 15 per cent. of friction.

The length of this article will not allow us to go into the distribution of the power at different points of the individual stroke. This will be found interesting.

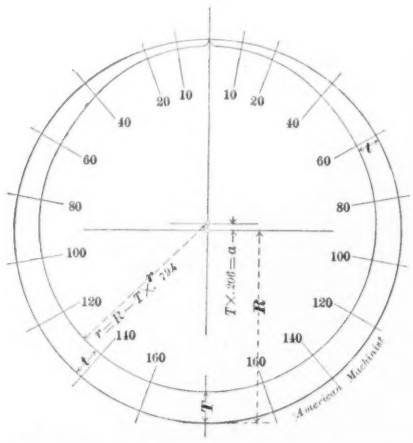
LETTERS FROM PRACTICAL MEN.

Piston Packing Rings.

Editor American Machinist :

In the discussion of the new Dunbar packing ring, by Mr. Richards, in the AMERICAN MACHINIST of October 12th, he states that so far as he knows, "there has been no authoritative determination of the correct eccentricity, or whether in fact the inside of the ring should be a true circle," in piston rings of that class. It has been done by Prof. S. W. Robinson, and may be found in Vol. II., page 19, Transactions of American Society of Mechanical Engineers, under the title of "A Rational System of Piston Packing." It may also be found in a more condensed form in Unwin's "Elements of Machine Design," tenth edition, page 450.

The "rationality" of the system consists of the method of calculating the thickness radially of a ring, so that when compressed into the cylinder it will spring uniformly along its entire length (instead of nearly all in one place, as a parallel ring does), and with the result that the pressure of the ring against the cylinder due to the spring is uniform around the entire circumference. There is no doubt that a parallel spring ring can be made to fit the cylinder when new, either by the Dunbar method, or the method by Mr. Richards and Mr. Scott, but the practical question is, What will be the effect of wear of such a ring on the cylinder?



Suppose the ring to be worn away until the initial stress or spring of it is relieved. The outside of it will be round like the cylinder. If you want to know what the shape of the inside will look like with a ring made on the Dunbar system, look at Fig. 9, in AMERICAN MACHINIST of November 9th. With the common parallel ring you can compare the two conditions by drawing the ring of the diameter it was before cutting, and drawing on top of it a circle the size of the cylinder, placing it wherever you think the wear would bring it. With the common ring there is one possible condition of wear which would leave the ring of uniform thickness, but still the wear would not be uniform, because after the ring is sprung together, and turned to fit the cylinder, it is not of uniform thickness.

With the Dunbar ring it is impossible for it to be left a uniform thickness by such wear, because it is a true circle on the inside only when first fitted in the cylinder. If a ring wears more in one place than another, and is fixed so it cannot turn in the cylinder, it must be obvious that the cylinder would be worn more at some parts of the circumference than at others.

The common parallel ring is a fairly good ring, if it is made to properly fit the cylinder when new. The spring in it takes place almost entirely at a point opposite the cut, and its action is much as if it was provided with a spring hinge at that point, but all cast-iron parallel rings have the fault that they wear unequally at different parts of the circumference. The "Rational System" is not difficult to comprehend as it is based on the comparatively simple idea of considering the ring as a curved beam, so proportioned that when a load or pressure is uniformly distributed along its length, it will be uniformly deflected along its length. The condition of a spring ring in the cylinder is about the same as that of a deflected beam, uniformly loaded, free at the ends and supported at the middle. As the two ends must be alike, we can take one-half of it as a beam fixed at one end. As it is to be of the same breadth the whole length, then to get proportional strength, and consequently uniform deflection, we must make the depth greatest at the fixed end and less toward the free end. The accompanying cut represents a ring proportioned on this plan. It is necessary to determine the depth T first, and to do this the pressure per square inch of ring against the cylinder must be decided upon.

Ramsbottom, the inventor of the spring ring packing, found by experiment that 3½ pounds per square inch were sufficient to make a ring steam-tight up to a difference of 100 pounds pressure on the two sides of the piston. It must have more than this at first, because the pressure is reduced by wear, and common practice gives from 10 to 15 pounds, when new. Assuming the expanded radius = to 1.1 radius of cylinder, and modulus of elasticity for cast-iron 17,000,000, then for a pressure of 14 pounds, T will be .06 R. To find the depth of the ring at other parts, space it off in degrees as shown, then t at each point will be,

At 10° $T \times .197 = t$
20° " $\times .311 =$ "
40° " $\times .489 =$ "
60° " $\times .63 =$ "
80° " $\times .745 =$ "
100° " $\times .837 =$ "
120° " $\times .908 =$ "
140° " $\times .96 =$ "
160° " $\times .99 =$ "

For other pressures T is found by

$$T = R \sqrt[3]{\frac{P}{64{,}400}}.$$

If T is known, pressure P is found by

$$P = 64{,}400\ \frac{T^3}{R^3}.$$

Nearly two-thirds of the inside of the ring is approximate to a circle formed by radius r with center placed as shown in cut. By the above system the ends of the ring would be wedge-shaped, but as this would not do in practice it would be necessary to make the ends a depth exceeding somewhat the difference between the expanded radius and the net radius, and therefore it answers very well to continue r around to the ends. A cast-iron ring proportioned in this way will give a much more uniform pressure along the outside than is possible with any parallel spring ring, no matter how it may be made, and consequently more uniform wear in the cylinder.

Mr. Dunbar sees some necessity for this when he says the ring shown in Fig. 11 "is too stiff at B opposite the cut," but he makes it that way because it is thought that will be required to preserve the "rotundity" as it wears. Truly a very good reason, but why not distribute that "stiffness" around the ring in due proportions instead of having it all in one place?

The mathematics of the eccentric ring is probably correct, it having been evolved by men who are not mere theorists but practical mechanics, but those who wish to investigate the reasoning on which it is based can find it in the books to which I have referred.

I am aware there are a number of good mechanics who use the parallel ring and think it just as good as any other shape, but this is not proof positive that it is as good. There are many successful things that seem entirely wrong in theory. There are two apparent reasons for this; first, the cost of making or cost of operation may forbid the use of the theoretically correct; second, the theory may be incomplete. When these reasons do not exist there is no more reason why we should construct in violation of theory than that we should attempt to raise water a hundred feet by a simple vacuum.

The eccentric ring can be made as cheaply as the parallel, and it has been shown by experience that it will operate without trouble. It is closer to the theoretically correct shape, and therefore the burden of proof rests on those who offer a ring of another shape. They must demonstrate beyond a doubt that it is better before it will be generally accepted in engineering practice.

BELL CRANK.

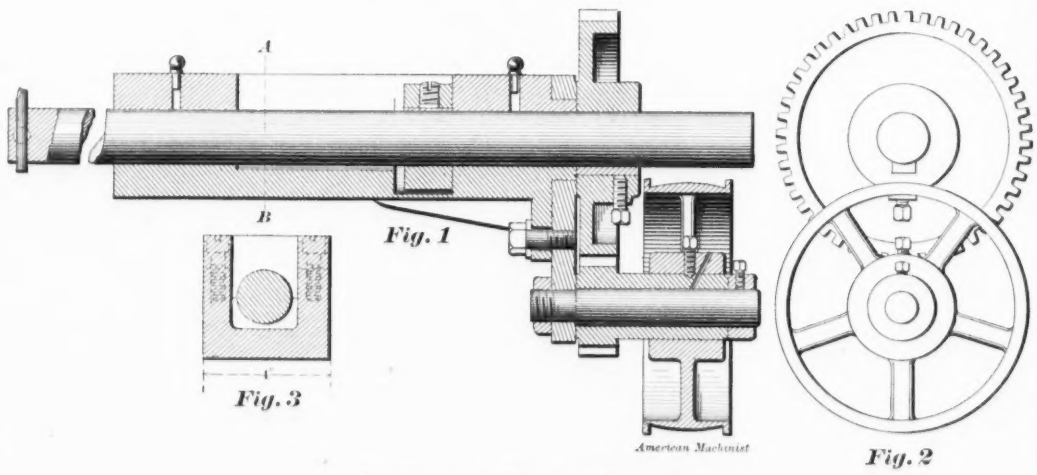


Fig. 1

Fig. 3

Fig. 2

DEVICE FOR BORING CRANKS.

Device for Boring Cranks.

Editor American Machinist :

I once had a hand at devising and in making a tool for this purpose, of which I send you a drawing with a few improvements that I think would make the tool a little more convenient than the one we made. Fig. 1 is a longitudinal section. Fig. 2 a rear end view and Fig. 3 a section through $A\ B$.

It is only intended for such large lathes as have studs and clamps for holding the tools, so that the box section can be clamped on the tool-post the same as other tools. It is driven from a drum on the countershaft, and for feed we found (on that particular lathe) that by making a short shaft and two gears we could drive the regular feed works from the loose cone, and so get all the changes of feed.

The one we made had the driving gear keyed fast to the boring bar, and a solid collar on the front end nearest the cutter.

As you will see, by making it as shown the bar can be slipped through the gear and collar and be made to overhang just as much as the work requires, and no more, and then by putting the collar inside the work can be done with less overhang of the bar. The bar can also be easily changed for one that is turned down on the end so as to bore smaller holes.

The driving pinion is shown mounted upon an arm that is journaled concentric with the boring bar, so the tension of the belt can be easily adjusted to suit the different positions of cross-slide, a feature that the one made did not have, and one that will also make it more convenient to change pulleys for a change of speed. I think the construction will be easily understood from the drawing, so I will not attempt to describe it further.

A MECHANIC.

Straightening a Screw.

Editor American Machinist :

Observing in your issue of Nov. 30, some data referring to calculations on screw threads, it occurred to me that, perhaps, I might learn something in a practical way through the aid of your columns, by placing before your readers certain facts which have come under my own observation.

Being connected with a manufacturing concern where in the construction of one machine it is necessary for us to use a large screw of peculiar shaped thread, which transmits a considerable amount of horse-power, the strain on the nut being about 15 tons, we find it is difficult in starting the machine to keep the screw perfectly true. In making the screw we proceed as follows :

After turning it as we think very carefully, we next turn spots about 18 inches

apart for our steady rest; and, then using two steady rests on the bar, say about 20 feet long, and on the carriage a special rest similar to a shafting rest, we proceed first to rough-turn it, then finish it, then to cut the thread, the outside diameter of which is 4 inches in size, bottom of thread 3¼ inches with a 1½-inch pitch. After being turned and finished, the bar is perfectly true; but on cutting the thread we find it runs out, a fact, due, I think, to relieving initial strains in the bar by removing the amount of metal necessary in the cutting of the thread. The method adopted in straightening it, is to pene it; there being no other that I can think of; but on putting the screw in the machine to do its work, we find that in time it begins to run out again, and this, I think, must be due to the initial strains still existing in the bar; the short places being drawn out by continuous traveling up and down.

It would be interesting to me and, doubtless, to many of your readers, if you could furnish any information which would account for the bar running out as above described. If you have had anything of the kind under consideration before and which has appeared in your columns, I would be much obliged if you would kindly refer me to it. S. M.

[Our experience leads to the conclusion that pening is not a proper method of straightening such a piece of work as is named above, and that where pening is resorted to, the work very seldom remains true in service. The reason for this seems to be that in straightening by pening a force tending to lengthen one side of the work is set up, this force being applied to only a very thin skin of the metal, and being, of course, only just sufficient in intensity to overcome the equal opposing force tending to bend the work, this latter force being distributed throughout the remainder of the section. The smaller section affected by the pening may be, and we believe often is, strained beyond its elastic limit, and as soon as the screw is put to work and additional strains imposed, the balance between these two forces is destroyed, often permanently.

Especially is this the case where the pened surface is subject to wear in service. Such a screw as described nearly always springs during the cutting of the thread, and, in our opinion, can only be properly straightened by a screw or other form of press.—ED]

The Discussion About Milling.

Editor American Machinist:

In your issue of November 30th, "Easy Way" seems to think it strange that I had to go "West" to find out about running the work with the milling cutters, when the real facts of the case are that it was on the train that I met the toolmaker in question, who happened to be from New England—from Lynn, I think.

Never having been engaged in very much milling work, I will admit that I had never known that it was common practice to mill with the work, and my contact with milling machine men, even in Worcester, has not led me to think it is used by even a majority of mechanics. When the makers of nearly every milling machine on the market give instructions in the "Directions" accompanying the machine to mill against the work, it can hardly be called common practice to mill the other way, even if certain Hartford parties are doing it that way. I had not thought that milling with the work could be economically practiced in cases of scale of any kind, and in finding that it can be done, I and probably many others have gained valuable knowledge, for which I thank all who have contributed to this information, "Easy Way" among the rest. Since reading the facts that milling with the work is an advantage, and seeing the reasons for it, I have become a convert to it in places where you have a milling machine that will stand the test for lost motion in the carriage, or can be rigged to stand it, but at the same time it seems to me that "Easy Way" is a little unfair in supposing that every one knows what is being done in Hartford, and in giving the impression that his way is generally used, when I think the old way has the most advocates, even against the facts shown in the late discussions.

So that even though I may have displayed ignorance as to the latest practice in surface milling (and all other milling using the same class of cutters,) the readers of the AMERICAN MACHINIST are the wiser for it if they have profited by the discussion which I seem to have stirred up.

FRED H. COLVIN.

At Keeport, Ind., William Laycock, an engineer, was attacked with heart disease while in the act of firing his boiler. He fell in the door and was burned alive. When he was discovered his remains were burned beyond recognition.

Trouble between two workmen in New York brought them before a police justice, where it come out that one of them was engaged in making trousers for ten cents a pair, and the other offered to make them for six cents.

William Sellers & Co. have supplied to the Philadelphia mint a powerful hydraulic coining press, which is especially adapted to coining medals much larger than any of our coins, and therefore requiring much greater pressure. The press furnished is capable of exerting a pressure of 2,000 tons, and is driven by a three-throw pump electrically driven.

Meeting of the American Society of Mechanical Engineers.

In accordance with the previously announced programme the regular autumn, or New York meeting of the American Society of Mechanical Engineers began Monday evening, the 4th inst., at the society's house by the address of President Eckley B. Coxe, the attendance being unusually large. After some preliminary remarks of welcome and of congratulation upon the prominent part occupied by work of the members in the recently closed Exposition at Chicago, Mr. Coxe delivered the regular formal presidential address, which in this instance was a decided departure so far as its character was concerned, from the usual form, the address being, in this case, a record of experience at the Drifton collieries with the matter of testing coal in such a manner as to indicate to large consumers a practicable method of arriving at conclusions respecting the relative values of different coals. The apparatus used in the work was illustrated by drawings and photographs which were thrown upon the screen; that for determining the relative amounts of coal and slate, however, being exhibited. In making this test a solution of chloride of zinc is used having a specific gravity somewhat less than the slate and greater than the coal, the result being that a properly prepared sample (and upon this matter of the proper selection and preparation of samples of coal Mr. Coxe lays special stress) when poured into the solution is separated, the coal floating and the slate sinking. These are then washed, dried and weighed. This test was declared to be not only much quicker and cheaper than separation by hand picking, but also more reliable, the specific gravity being a much better indication of quality than the appearance.

Special stress was also laid upon the importance of sizing of coal to be used for steam making; variations, or rather, mixtures of different small sizes being especially to be avoided. Apparatus was shown for testing this point as also for determining specific gravity of a large sample (up to 30 or 50 pounds) the author calling attention to the point that there is a very close relation between specific gravity and percentage of ash. Mr. Coxe gave his assistant, Mr. John R. Wagner, credit for valuable help in the work, and the paper was an eminently practical and valuable one, of which we may have an opportunity to give some further account when there shall have been time to prepare engravings.

At the conclusion of the address, and after an invitation had been presented from the Engineers' Club through Mr. Holloway to partake of its hospitality, the members present adjourned to the banquet room in the basement and enjoyed a lunch and informal reception.

TUESDAY MORNING'S MEETING.

The first thing on the programme for this meeting was the reports of standing and special committees; most of these reports having, however, been presented in full at the Chicago meeting though not acted upon because of some technical difficulty arising from the fact that the Chicago meeting was part of the Engineering Congress. The reports were therefore read by title only, and the committees were discharged or continued, as the case demanded.

The annual report of the Council was then presented; the following being its most important points:

To meet the expenses connected with the maintenance of an engineering headquarters in the city of Chicago during the Exposition, there had been contributed by interested members $2,442.45, of which only $2,000 was required, the balance of $442.45 to be invested in the interest of the society.

A committee had been appointed also specially charged with the entertainment of visiting foreign engineers here in New York, its efforts having met with great appreciation.

Pursuant to action at the last annual meeting the Council had appointed a committee on Standard Thickness of Uncoated Metal in Sheets and Plates, consisting of Messrs. Towne, Egleston, S. S. Wheeler, Oberlin Smith, S. T. Wellman, and Geo. M. Bond.

Among the gifts to the society during the year were a model of the Ericsson "Monitor" presented by Thos F. Rowland, a member who took a prominent part in the building of that vessel; a portrait in oil of Joseph Harrison, builder of some of the earliest locomotives, and the builder of the boiler which bears his name. This was presented by his widow. An oil portrait of Robert Fulton had been loaned the society by Mr. Alanson Cary. It is thought this portrait was painted by Fulton himself while a student of art. A bust of Watt had been presented by Mr. Erwin Graves.

By action of the Mechanical Section of the Engineering Congress, convened at Chicago in connection with the Columbian Exposition, certain matters were referred to the Council.

It has been deemed inexpedient to comply with the request from this meeting that this Council appoint a committee to co-operate with the committee of the American Railway Master Mechanics' Association, for the purpose of carrying out a test at the laboratory of Purdue University of one simple and one compound locomotive.

It was the sense of the Council that while scientific investigation of fundamental data and principles would be an important and useful function of the Society, it was, on the other hand, very unwise for the Society to enter upon investigations by an appointed committee upon issues which could be made matters of controversy by parties commercially interested, and which would involve the Society, through its representatives, in an apparent alliance with one or another manufacturing enterprise.

A resolution was offered amending Article 18 of the rules, so as to give to the Council power to remit at its discretion the dues for life membership where it was thought advisable, and notice of an intention so to do had been given at a previous meeting, and when the person to be elected to a free life-membership had been a regular member for ten or more years. It was brought out in discussion that this was to cover cases in which a member, creditable to the society and who had been for years identified with it, had, through some misfortune, been rendered unable to maintain payment of dues. A member evidently understood from the wording, however, that it was the intention to repay to a life member his $200 membership fees in case the Council so decided; and as this was not the intention, further consideration of the matter was deferred until the evening meeting to give time to change the wording of the amendment.

During the year the society had lost by death fifteen members, and favorable action had been taken on 117 applications for membership in the several grades. At present there are 1,317 regular members, and a total membership of 1,650.

Appended to the report of the Council was the following:

MINUTE TO THE IRON AND STEEL INSTITUTE OF GREAT BRITAIN.

It having come to the knowledge of the Council of the American Society of Mechanical Engineers that the Iron and Steel Institute of Great Britain has recently bestowed upon a member and ex-vice president of the society the "Bessemer Medal" for 1893, the Council avail themselves of this occasion to tender their congratulations to Mr. John Fritz on the receipt of such a well-merited and distinguished honor, from his friends beyond the sea.

The Council desires to commend the excellent judgment of the Iron and Steel Institute in selecting for this honor one who, by his genius, skill and industry through many years, has done so much toward the improved metallurgical processes, and especially in the construction of the mechanical appliances now in use in the manufacture of iron and steel in this country, as to have materially aided in making this industry the important one it now is.

That in conferring the "Bessemer Medal" in this the year of our "Columbian Exposition" upon an American engineer, the Institute has in a pleasant way added further evidence of the kindly feelings and hearty good fellowship which in so many ways has of late marked the action of engineering societies and engineers in this country and in Europe; and we cannot but believe courtesies like this tend to a closer union of engineers in all lands; that while it is the mission of our profession to compel the rude forces and materials of nature to contribute to the welfare and comfort of mankind, it is their mission as well to bring in closer touch nations and individuals, and in this way, aiding, in a degree it would seem no other profession can, to bring about those better days which in all ages past the world has hoped and struggled for.

A second appendix gives particulars of the arrangements for entertaining the representatives of foreign engineering societies.

The committee having this in charge had received in subscriptions to bear expense of entertainment $5,114 50, and had left out of this after defraying all expenses a cash balance of $2,408.06, which was to be returned to subscribers, and amounted to 48 per cent. of subscriptions, plus $2.00 which would be paid to each subscriber, a rather remarkable showing for a committee charged with duties of this character.

The report of the Finance Committee was then given, and this showed the following facts, this being the close of the second year since an increase of $5 per annum was made in the dues of all members. The report shows that the total received from dues, sales, publications, etc., is $27,131 38, and by summing up all the expenses for running the society they are found to reach a total of $23,019 90, showing that the income of the society from dues and other sources, exclusive of initiation fees and life memberships, is in excess of the running expenses by $4,111.48, leaving receipts from these latter sources to be invested as capital from which the society can derive an income.

(*Continued on page* 9.)

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The Dry Dock Boiler Explosion.

It appears to take those responsible for the laws governing boiler inspection in New York City a long time to find out that a hydrostatic test is not sufficient to determine the condition of a boiler as to its safety. In fact, there is no evidence that they ever will learn it, though it would seem the disastrous effects of the Dry Dock and Battery Railway explosion, an account of which appeared in our issue of November 16th, if properly presented, might stir them up a little towards a realizing sense of what they did not know about boiler inspection. Sergeant Mullins, of the police department, who has the matter of boiler inspection in charge, is reported as saying that he has long been of the opinion that the hydrostatic test was insufficient—which could not be doubted if it is assumed that he is fit for the position—but that he has not been able to impress his views upon the law makers in a way to have the rules amended.

The verdict of the jury concerning this explosion called it an "accident," which was wrong to begin with. It was no more an accident than when two railroad trains meet at full speed through an engineer guessing that the other train is behind time, and pulling out for the next siding. It was right, however, in concluding that the hydrostatic test was not sufficient.

Sergeant Mullins is of the opinion that the boiler was all right six months before the explosion, but that at that time it was burned and rusted. How he knew it was all right at the time stated he does not say, and we have no doubt he was mistaken. We do not believe that it got into the condition it was in when the explosion occurred in six months' time; that is altogether improbable. He also believes parts of the boiler to have been red hot at this time. We have seen nothing to indicate that the boiler was overheated, and believe that it was not. Our opinion is that the boiler let go because it had become so thin in places that there was not strength enough to hold the pressure allowed, with a little extra strain incident to opening the throttle, which caused some commotion in the water. Instead of being in good condition six months before the explosion, the plates had, beyond much doubt, been growing thin in spots for years, a fact that would have been revealed by a proper internal and external inspection.

The hydrostatic test has never been considered conclusive by the best engineers, and has always, by some, been considered dangerous. At the present time no engineer of ordinary intelligence places dependence upon it alone, and others will not willingly have it applied to boilers in their charge beyond the limits of the ordinary running pressure. In the first place there is always the danger of unduly straining the boiler by the cold over-pressure; and second, any one knowing the different strains in a boiler as between hot and cold, finds little to assure him in the hydrostatic test.

We believe that this example should be sufficient to stir up the authorities to get somewhere near current practice in inspecting boilers, and incidentally to amend the rules governing the examination and licensing of engineers in such a way that no one shall have boilers in charge if he cannot satisfy his examiners that he knows how to go to work to properly inspect their condition, nor be left in charge except he does make such inspection at intervals to be decided upon from a consideration of the conditions under which the boilers are operated, and the quality of the water. This, in some instances, may call for the employment of better engineers, which is something on all accounts to be hoped for. The very first requisite of safety is an engineer who does not have to be told whether or not his boiler is safe.

This particular explosion has revealed nothing new. It has only emphasized the old truth that boilers will wear out, and that it is important to know how fast they are doing so. Just as many other boiler explosions, it has its lessons, from which it is to be feared that nothing will be learned. It may be hoped, however, that the contrary will prove true. It is a matter that should be agitated.

John Tyndall.

In the death of Prof. John Tyndall, which occurred at Haslemere, Surrey, Eng., on December 4th, the world loses one of its great scientists. Great in his ability for profound investigation, and almost greater in his ability to set forth the results of these investigations, and his conclusions, in a way not only to be comprehended by the masses but to charm the masses into following him with unflagging interest. It is safe to say that such works as his "Heat Considered as a Mode of Motion" have been the means of imparting to thousands a knowledge of heat which they would never otherwise have possessed, and so with others of his works in which the results of mighty research and study are given in language so simple and expressive as to rivet the attention of the most ordinary reader; in language as felicitous as that made use of by the foremost writers of fiction.

Like many another who has left a void behind, Tyndall worked his way to eminence from an humble beginning and scant education, in this respect affording another example of what may be accomplished by strong determination and untiring industry. The world is better for such men having lived in it, and poorer for their loss. Professor Tyndall was born at Leighton Bridge, Ireland, in 1820.

As to Dutch Merchants.

To judge from present indications, we should say that nearly if not quite every American manufacturer of machinery whose name and address appears in the pages of this journal has, or will receive an order to ship machinery to some firm in Holland. We continue to receive letters from our friends telling of their experience in this line, and in one case machinery was shipped and its receipt promptly followed by another very flattering (and larger) order, "payment for both to be made on receipt of the second shipment," a shipment which was, of course, never made, and the first one remains unpaid for.

We find exemplified in this correspondence, too, what is undoubtedly one of the worst features connected with swindling operations, *i. e.*, distrust and suspicion of people who are presumably honest, and whose propositions, we think, ought to be investigated and treated upon their merits, whereas in several instances communications are disregarded simply because they come from Holland. In one instance a manufacturing firm received two letters from representatives of foreign concerns, these representatives having been in Chicago and written the letters before leaving for home, asking that catalogues and descriptive matter be sent, one of these with a view to representation at the coming Antwerp exhibition. After such investigation as we have been able to make in these cases, our conclusion is that there is nothing to show but what they are *bona fide* business propositions, which might lead to establishment of profitable business relations. So far as we have been able to find out, there is at least no evidence to the contrary, and that it would be perfectly proper to open correspondence with them, until some suspicious circumstance developed, such, for instance, as an order to ship goods without security for the payment. It should not be overlooked that there are honest men in Holland as well as in the United States, and it would be a pity to refuse to enter into correspondence with one of these on a business matter, because there are also swindlers there. In other words, the fact that there are a number of concerns in Amsterdam—and probably in other cities of Holland as well—who make a business of preying upon foreign machinery builders, should simply cause American builders of machinery to be very cautious, and to send no machinery without full assurance of responsibility and honesty; but unless the name of a correspondent appears in our published list, the presumption should be in his favor, we think, unless there is some inherent reason for suspicion. Belgian merchants may be expected to be unusually active in their efforts to establish foreign trade relations within the next year, on account of their coming exhibition at Antwerp, and such relations may easily be profitable and advantageous to American builders of machinery; but it will be well to exercise reasonable caution in establishing relations with them.

The positions of the companies operating the electric cars in Brooklyn and the cable cars in New York appear to be practically identical. Both seem to be waiting for some one to invent and test a safety guard that will not cost them anything and will somehow reduce operating expenses. At present safety to pedestrians appears to be in favor of the cable cars because they cannot be run faster than the cable moves, while a spurt of twenty miles an hour is easy enough in the instance of the electric cars.

Since the foregoing was written we are informed that the Brooklyn Company are about to apply a device which it is believed will be instrumental in saving life. This device is something that has been tried with success elsewhere, and it is hoped will serve its purpose equally as well in Brooklyn.

The list of qualifying words that are attached to that rather convenient and altogether common term engineer is constantly being added to The last to come to notice is "rural." From an advertisement in a daily paper it appears that a "Rural Engineer" is one who offers his services to the possessors of country estates who want to improve their grounds, erect buildings, dig wells and the like. Rather a useful man after all.

A quite natural but rather uncommon accident occurred recently in a Pennsylvania town. The gas was left burning in a storage vault for the purpose of drying it. At night the door was closed, the gas went out for want of air, and the vault became filled with gas. In the morning an attempt was made to light the gas, the result being an explosion that considerably injured the building and one man.

Literary Notes.

THE CONSTRUCTOR. A Hand-book of Machine Design. By F. Reuleaux, Professor at the Royal Technical High School at Berlin, Royal Privy Councillor, Member of the Royal Technical Deputation, Honorary Member of the American Society of Mechanical Engineers, etc., etc. With portrait and over 1,200 illustrations. Authorized Translation Complete and Unabridged from the Fourth Enlarged German Edition. By Henry Harrison Suplee, B. Sc., Member of the American Society of Mechanical Engineers, Member of the Franklin Institute.

It is remarkable that this work, first published in 1861 and revised at intervals, translated into different European languages, should never until this time have been translated into English. Beyond question this has been a distinct loss to English speaking engineers. To be sure, fragmentary translations have appeared in print, for the most part from German engineers in the United States and England and generally in the way of discussion, and the author's name has been used as authority in text-books, but in this way but little of the ground has been covered, and that in a way, for obvious reasons, very unsatisfactorily available. Still, although to the great majority of American and English engineers this work has been practically sealed by the difference in language, enough has been seen in a disconnected way to firmly establish the standing of the author, even if it were not so well known by universal repute.

The scope of the work need hardly be referred to. It is told in the title, though we think much better in the author's preface, in which he incidentally refers to the "principal object of the work" as the "treatment of the practical construction of machine details."

The conclusions—rules—as in most similar works of the present are stated in mathematical formulas. But these as compared

with much work of similar nature are for the most part comparatively simple, and are such as must be mastered by those who would avail themselves of the use of many of the fairly simple text-books of the present day.

The translator of this work has performed a task for which American and English engineers, and English speaking students of mechanical construction are sure to thank him. In the original the metric system of notation is employed. This he has changed to the English system; something that in itself involved an immense amount of labor and required the practice of the utmost care and patience. The entire work of translation is highly commended by the author. It is published by the translator, H. H. Suplee, West Chelten Avenue, Philadelphia, Pa. Price, $7.50.

The Engineering Review, of London, which is edited by Mr. J. S. Deans, has undertaken the work of presenting each month a short account of what of special value has appeared since its preceding issue in all the engineering publications of the world. It is a large undertaking but has been well begun and the publication will no doubt prove of very great value to engineers who are too busy to regularly read all that is appearing in the way of technical literature.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(601) L. A. C., Goshen, Ind., writes: Please inform me of the correct way of finding the degrees of a circle. Do not give algebra as I do not understand it. *A.*—Divide the circumference of the circle into 360 parts, and from the points of division draw lines to the center, the angle formed by any two adjacent lines is an angle of 1 degree.

(602) S. R. T., Cincinnati, O., writes: Reading the AMERICAN MACHINIST every week, I see some very good illustrations and descriptions of various things, and thought by writing to you I might get some desirable information on stuffing boxes. *A.*—Illustrations of, and the rules for finding the dimensions of stuffing boxes are given in our issue of October 1, 1887.

(603) B. G. A., Corinth, Mass., writes: Please give me the best graphical method or a rule for finding the relative diameter for cone pulleys for equal tension of belt on different speeds or steps of the same. *A.*—You will find this subject discussed and graphical methods given in our issue of December 1, 1888. We believe these methods to be as good as any other; they are comparatively simple and can be easily applied.

(604) F. W. T., Hinsdale, N. H., writes: I inclose a clipping from your paper relating to an organization formed in St. Louis, whose object is the development of new ideas and the encouragement of inventors and men with patentable ideas, but lacking the means to place them before the public. Kindly inform me if this organization is still in existence? *A.*—We have not heard anything of this organization since it was started, and we do not know whether it is still in existence or not.

(605) N. E. R., Chicago, Ill., asks: Did you publish a series of articles about two years ago in reference to laying out molding machine knives? If so, can I get them now? *A.*—We did not publish a series of articles treating on this subject, but in answer to Question 341 in our issue of July 30, 1891, we gave a method of laying out a knife for a wood-working molding machine; this method is applicable to laying out any knife of this kind. We can furnish this number at any time.

(606) C. W. H., Brantford, Canada, writes: Kindly inform me what will remove borax and scale from brazed work. I wish to use it in connection with brazed bicycle parts. I have tried sulphuric acid and water, and if mixed strong enough to cut the borax and scale it eats into the tubing. I have mixed the pickle in proportion of 1 acid to 4 of water and heated pickel with steam. *A.*—We do not know of any other method than you have adopted, excepting the removal of the scale by a file or other suitable tool.

(607) W. T., Jamaica Plains, Mass., writes: Please give me any information you can regarding the use of hair-felt for preventing vibrations in engine foundations. I understand it is used somewhat to deaden the sound when the engine is running. *A.*—When small engines are placed on an upper floor of a building hair felt is sometimes placed between the floor and the bed-plate of the engine for the purpose of deadening the sound so as not to annoy others working on the floor below; but it will have very little, if any, effect on preventing vibrations.

(608) F., Camden, N. Y., writes: I want to make strong magnets from ¾x⅜ steel. Is not tool steel the proper thing to use? And should they not be tempered, drawn down to blue? *A.*—Tool steel will make good magnets. Steel of high temper is the only metal capable of both acquiring and retaining magnetism to a sufficient degree for practical purposes. The portative force, or the attractive property of the magnet, is governed by the mass and temper of the steel. 2. What is the use of the small bar across the ends of a magnet and supplied with it? *A.*—This small bar made of soft iron and furnished with horseshoe magnets, called the armature or keeper, is supposed to have the ability to prevent magnetic loss by completing the magnetic circuit.

(609) G. D. C., St. Johns, Mich., writes: Please inform me which book, and from whom I can procure a book treating on fancy glass blowing. I know nothing of working glass and would like a book on this subject. *A.*—Appleton's Cyclopedia of Applied Mechanics has a good description of the manufacture of glass. If there is a public library in your town you will probably find it there so that you can examine it before buying. It is a very useful work to have as it treats on many other subjects. It also contains a list of some of the most valuable treatises on the subject of glass, from which you can make your own selection. Probably, "Wonders of Glass Making in all Ages," will be a good book for you. These you can obtain from any dealer in scientific works.

(610) A. G. C., St. Louis, Mo., writes: In your answer to Question 543 in your issue of November 2d you give a formula for finding the thickness of hydraulic cylinders $t = \frac{p \times r}{10{,}000 \times p}$; and in the example you give 18 inches for the diameter of cylinder, and a pressure of 15,000 pounds per square inch. From where do you obtain the 6 in the solution of the problem? Should it not be 9 inches equal to the radius of the 18 inch cylinder? I make the thickness 1.58 + inches. Am I right? *A.*—The given diameter, 18 inches, is a typographical error and escaped our notice; it should have been 12 inches. You will find that this question refers back to another one in which the diameter of the cylinder is given at 12 inches. The thickness for a cylinder 18 inches diameter as computed by you is correct. We thank you for calling our attention to the error.

(611) A. D., Philipsburg, Pa., writes: Please let me know the proportions of a worm and wheel which have to transmit 20 horse-power. The worm runs at the rate of 800 revolutions per minute, and at 5 to 1 on the wheel. Also please state whether cast steel would not be the best material to use for both worm and wheel. *A.*—There is evidently a mistake in the statement of your problem. You say that the worm is to run at the rate of 5 to 1 on the wheel. We understand by this that the wheel is to have 5 teeth only, such a wheel is impractical and cannot be used. We suppose that you accidently left out the 0, and meant to say 50 to 1. Under these conditions the wheel will have 50 teeth, the pitch should be 1½ inches, width of face, 2¼ inches; diameter of worm, 6 inches. Steel is the best material to use under the given conditions, the dimensions here given are for steel, for cast iron the pitch will have to be much greater.

(612) W. J. C., New Orleans, La., writes: I have been reading the book on "Modern Locomotive Construction" with much interest, but there a few points which I would like to have cleared up. The principal one is in connection with the rule for finding the thickness of the guides. I recognize the rule given as the ordinary formula for beams, but am not clear on the value of the constant 1,200, how is this obtained? From your remarks about the modifying influence of the weight of crosshead and guide, I infer the problem is somewhat complex. Could you refer me to an exhaustive treatment of the subject? *A.*—For the investigation of the strength of beams, the following well known formula is used:

$$M = \frac{S\,I}{c}, \qquad (1)$$

in which M is the bending moment; S the tensile or compressive stress upon the remotest fiber from the neutral surface; c the distance from the neutral surface to the most remote fiber; and I the moment of inertia. For a rectangular cross section, the moment of inertia I is equal to $\frac{b\,d^3}{12}$, in which b is the breadth of the beam in inches, and d the depth in inches. The value of c is in this case equal to $\frac{1}{2}\,d$. Now substituting these values for I and c in formula (1), we have

$$M = \frac{S \times b \times d^3}{\frac{1}{2}d \times 12}, \qquad (2)$$

which reduces to

$$M = \frac{S\,b\,d^2}{6}. \qquad (3)$$

Engineers usually adopt a value of 10,000 to 12,000 pounds for S for wrought-iron, and from 12,000 to 20,000 for steel. Since the formula must give sufficient strength for wrought-iron guides, we have adopted 11,000 pounds for the value of S. For a beam supported at one end and loaded at the other, the bending moment is equal to $W\,l$, in which W is the load in pounds, and l the length in inches; from this we get

$$W\,l = \frac{11{,}000\,b\,d^2}{6}. \qquad (4)$$

A beam loaded in the center, and firmly fixed at the ends, as the locomotive guides are supposed to be fixed, is eight times as strong as the above; hence we have

$$W\,l = 8\,\frac{11{,}000\,b\,d^2}{6}, \qquad (5)$$

which reduces to

$$W\,l = 14{,}666\,b\,d^2. \qquad (6)$$

If the length l is taken in feet, we have

$$W\,l = 1{,}222\,b\,d^2.$$

For simplicity and safety we have adopted 1,200 instead of 1,222. Any good text-book on the strength of material will give you all the information required in the investigation of the strength of beams. We generally use Professor M. Merriman's text-book on the "Mechanics of Materials." 2. I find that in Fig. 244 the lower guide is represented to be considerably thicker than the upper one. As the description of practice and proportioning seems to contradict this, I would like to know if the illustration is correct. *A.*—The illustration is correct. The reason for making the lower guide deeper than the upper one is to obtain a sufficient depth of guide to keep the piston rod in a straight line laterally, as stated in Rule 28 We see no contradiction in regard to this matter. 3. I find that one authority adjusts the links for equal cut offs at half stroke and maximum cut off, equalizing the lead at mid gear, but letting it go at full gear. Is this good practice as compared with the method given in "Modern Locomotive Construction"? *A.*—We believe that in some shops the lead is equalized at mid gear, but we have always obtained better satisfaction by equalizing the lead at full gear, and allow it to be unequal at mid gear. 4. I notice that inside lap is advocated for slow-moving engines running on steep grades. By retarding the release the steam in expanding follows the piston further, and thus more power is obtained, and on account of the low velocity plenty of time is had to get rid of the steam in the cylinder. Is this right? But it seems to me that the compression is also increased by the early exhaust closure. *A.*—You are right; the small increase of compression will not have any hurtful effect, because in running up a grade steam is cut off later, and the compression will not be as great as when the links are hooked up.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila., Pa. See p. 13

Forming Lathes Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Seiden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N. Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

Steam Pressure Regulators, Reducing Valves, Safety Checks. Foster Engineer'g Co., Newark, N. J.

The American Packing Ring is up to date. J. H. Dunbar, Youngstown, O.

Upright Drills, stationary head, W. & L., with or without B. G. J. E. Snyder, Worcester, Mass.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton Avenue, Philadelphia, Pa.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc; machinery name plates in brass and aluminum.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

Meeting of the American Society of Mechanical Engineers.

(*Continued from page* 7.)

The Library and House Committee reported the continued success and usefulness of the library and of the provision of rooms for the accommodation of members during visits to the city, the income derived from the latter during the year having been about $1,200.

At the conclusion of the report, the presentation of papers was taken up, the first being that of Mr. A. K. Mansfield on "The 'Buckeye' Valve Gear." This paper was presented in abstract by the author, and is in the main descriptive and explanatory of the construction and operation of the valve gear of the Buckeye engine. The author thought this was entitled to be ranked among the so called classics of mechanics, and among other things showed how, with this gear, it was not necessary or desirable to provide a dash-pot mechanism for a high-speed engine, because after all it was a matter of port capacity and rapidity of valve movement, these being, in this engine, all that could be desired. Methods of accomplishing this by multiple port openings, where, as in some cases thought to be desirable, were shown. The recently adopted piston valves, now used in some cases of compounding and as exhibited at Chicago, were shown, and the statement was made that most of the objections against piston valves had been overcome in this application, one reason for this being that the travel of both the main and cut-off valves upon their seats was always uniform in extent, and that the wear was therefore much less injurious than when their travel varied.

This statement was called in question by Mr. Rockwood, of Worcester, who, after asking several questions—evidently with the idea that they could not be satisfactorily answered by Mr. Mansfield—stated that he had analyzed the valve motion and demonstrated to his satisfaction that the travel of the cut-off valve upon the main valve was not uniform in length and could not be, while it yet performed the governing function, saying that his investigation sustained the view of the "Special Commissioner" of *The Engineer* of London, who had asserted and proved to his own satisfaction, at least, by a diagram, that this travel was not uniform.

To all this Mr. Mansfield merely stated and repeated that his position was right and that the travel was uniform; variation of cut off being effected by *time* of movement of cut-off valve, not by change of amount of movement; that this could be demonstrated geometrically, though it was not necessary to go into the demonstration at this time. In the course of his remarks he mentioned the instance of a graduate of an engineering school who visited the World's Fair and saw the working model of a Buckeye engine made by cutting one in two horizontally in such a manner as to show all the movements of the piston and valves. The graduate after studying this model said: "I had supposed I had understood the Buckeye valve gear, and my graduating thesis had that gear for its theme; but now I find I have never before understood it at all."

Finally, by the help of Messrs. Holloway, Ball and Coxe the matter was made plain without resort to the apparently impending geometrical demonstration.

An appendix to the paper was suggested by the learned disquisition of the "Special

Commission" above referred to, this appendix showing how a uniform movement of both valves upon their seats could be produced without employing the compound rocker arm which is a prominent feature of the Buckeye valve gear.

The next paper was by Prof. R. H. Thurston, "On the Maximum Contemporary Economy of the High-Pressure Multiple-Expansion Steam Engine." This is a paper of some seventy pages, giving a record of a test of a pumping engine built for the city of Milwaukee, by E. P. Allis & Co., from designs by Mr. Edwin Reynolds in 1891. The engine is a triple expansion, vertical, inverted cylinder built to raise 18,000,000 gallons of water per day of twenty-four hours and guaranteed by its builders to perform a duty of not less than 125,000,000 per 1,000 pounds of dry steam. A description of the engine, as given in the paper, is as follows:

"The engine is of the vertical triple expansion type, with steam cylinders and parts above the bed-plate arranged somewhat similar to those of the modern marine engine. The capacity of the engine is 18,000,000 gallons in twenty-four hours, raised 160 feet, and the speed is 20 revolutions per minute, or 200 feet piston speed. The cylinders are three in number, one high-pressure, 28 inches diameter, one intermediate, 48 inches, and one low-pressure, 74 inches diameter, all having a stroke of 60 inches. The cylinders are mounted on cast iron A frames, which rest on heavy bed-plates carrying the main shaft journals. The cylinders are steam-jacketed, having the working barrels inserted as separate pieces. The steam and exhaust valves are located in the cylinder heads, their chests thus jacketing the latter. . . .

"The pumps are entirely below the floor. The fly-wheels perform the office simply of aiding in the regulation of the engine. Between each two cylinders is a receiver, heated by high-pressure steam. The volumes are, respectively, high-pressure, 101.3 cubic feet; intermediate, 151 cubic feet. In the high-pressure and intermediate cylinders the jackets are supplied with live steam at boiler pressure; but on the low-pressure cylinder the jacket is supplied with steam which passes through a reducing valve, and which has a constant pressure of 34 lbs. The steam is supplied to the high-pressure jacket by a pipe leading directly from the main steam-pipe; the exhaust from this jacket supplies the jacket of the intermediate cylinder, and this is led into a trap, the overflow of which ordinarily passes into the suction of the feed-pump for supplying the boilers. The exhaust steam from the low-pressure cylinder jacket is similarly received into a steam-trap and discharged into a feed-pipe.

"The exhaust valves of the low-pressure cylinders, when closed, are flush on the inside of the cylinder head, thus eliminating clearance due to exhaust ports. All the valve ports are located in the cylinder heads.

"The valve gear is of the Corliss type on the high and intermediate cylinders, and a combination of Corliss steam valves and poppet exhaust valves on the low-pressure cylinder. The clearances in the cylinders and ports are: H. P., $1\frac{4}{10}$ per cent.; I. P., $1\frac{5}{10}$ per cent.; L. P., $\frac{77}{100}$ of 1 per cent.

"The cut-offs of the high-pressure cylinder are under the control of a speed governor combined with an adjustable hand cut off. The cut-offs of the intermediate and low-pressure are controlled by a hand gear only, the point of cut-off in these cylinders being set usually in the inverse ratio of the cylinder volumes. Each steam piston has two rods connecting to a forged steel crosshead; from this crosshead extend four tie-rods to the head of the pump plunger, thus transmitting the motion direct from the steam pistons to the pump plungers, without passing through links or beams of any kind, making the machine direct-acting in the best sense of the term.

"The upper ends of the connecting rods take hold of the crosshead in the space between the two piston rods, the lower end connecting to its crank-pin. There are three cranks set at angles of 120 degrees, and the motion of each pump plunger being controlled by its own crank, tends to secure uniform flow of water through the pumps.

"The center crank (intermediate) is considerably larger than the others, and is fitted with drag boxes, to prevent the breaking of the shaft in case it gets out of alignment. There are two fly-wheels, 20 feet diameter, and weighing 50,000 pounds each. . . .

"The pumps deliver only on the down stroke, but the plungers are balanced to one-half the head, so that the work in the steam cylinders is uniform on both the up and down strokes, and the only load passing through the crank-shaft is that which is given to and taken from the fly-wheels at the beginning and end of each stroke.

"The pumps are three in number, one located beneath each engine. The plungers (32-inch diameter) are of the single-acting outside-packed plunger type, each plunger being driven from a crosshead. The valve chambers are cylindrical, and extend above the discharge valves, forming air chambers, on which rest one end of the engine bed-plates, this latter arrangement saving foundations, and at the same time rendering the pumps easily accessible. The pump valves are rubber, of small diameter ($3\frac{1}{2}$ inch), and are mounted in groups of 28, on "cages." There are seven of these cages (196 valves) in the suction and discharge of each pump, with an area about equal to that of the plunger.

"The engine is fitted with a surface condenser, the air, feed, and circulating pumps being driven by an arm extended from the low-pressure plunger. The air-pump is 22 inches diameter by 60 inches stroke, and is single-acting.

"Steam is supplied by a battery of five horizontal tubular externally fired boilers, with ordinary brick setting. Four boilers are ordinarily used, though three are ample for supplying this engine, four readily supplying steam for an additional 12,000,000-engine in the same building. The boilers are 66 inches diameter by 18 feet long, each containing 55 4-inch tubes, and having about 1,200 square feet of heating surface. The boilers have steam domes 32 inches diameter by 48 inches high, but have no mud drums. The boilers are fed by a perforated pipe extending the whole length of the boiler above the tubes, and just below the surface of the water."

Full details of the test, which was conducted by Prof. R. C. Carpenter, were given, and these showed that the engine developed a horse power on practically 12 pounds of steam per hour.

It is needless to say that the paper was vigorously attacked, because it has become a tradition of the society that such papers must be attacked, and the author or those making the tests described shown where and how they "have done those things which they ought not to have done, and left undone those things which they ought to have done."

What seemed to be regarded as an especially suspicious circumstance was the fact that the evaporative duty of the boilers was very low, this, in the minds of some, tending to show that there had probably been an error in determining the amount of water used. Professor Denton in an extempore talk showing remarkably comprehensive grasp of the whole subject expressed the opinion that if there had been no error (as he was not prepared to say there had been) then the builders of the engine had discovered a method of reducing cylinder and jacket condensation considerably below what had been attained by any one else, and he considered it to be plain that if the remarkable economy attained was due to the engine itself it would be found to consist in this reduction of condensation.

During the discussion Mr. Rockwood stated that he had designed a compound engine having two cylinders with a ratio of 1 to 6+, that had shown a coal consumption of 1.38 pounds of coal per hour per horse-power, without any deduction of any kind (even for ash) having been made. Mr. Rockwood advocates the use of only two cylinders in compounding.

The discussion of this paper took up so much time that the remaining paper that should have been presented was deferred until the evening meeting.

TUESDAY EVENING'S MEETING.

At this meeting the first paper presented was that on "Expansion Bearings for Bridge Superstructures," by Geo. A. Morison, of Chicago. The paper was presented by its author, and describes the ordinary bearings provided to allow for endwise and other movements of bridge superstructures, due to expansion by heat, wind pressure, change of loads, etc., shows their short-comings, and finally describes the author's form of bearing which consists of a number of what may be called segmental rollers, *i. e.*, rollers of relatively large diameter, so reduced in cross-section at the sides as to enable two and a half of them to be got into the space which would be occupied by one roller if not so reduced; special provision being made for preventing, by positive limitation of movement, the tipping of these rollers beyond the point of their proper bearing upon their cylindrical surfaces.

The paper was discussed by Mr. G. C. Henning who related the result of some observations made upon the actual movement of bridge bearings, and showing the necessity of providing for a free movement. As a matter of fact it was shown that these bearings were very seldom entirely stationary, the degree and location of expansion or contraction varying with the movement of the sun (especially in the case of a bridge standing north and south) and under such conditions a cloud obscuring the sun for as much as five minutes allowed the two sides of the bridge to assume nearly their normal positions, which were again disturbed as before after the passing of the cloud.

The deferred matter of the change in the rules previously alluded to was then taken up and the proposed amendment carried by a unanimous vote.

At this point a report was received from the committee on "A Standard Gauge for Uncoated Metal in Sheets and Plates"; Dr. Egleston, the chairman, presenting the report, the gist of which was that the committee favored a system of designation based upon actual measurement of the sheet or plate in decimals of some standard unit of measurement, and had corresponded with other societies with a view to securing, if possible, concerted action. Efforts in this direction had been carried also into foreign countries, where it was found in some cases, especially in the case of a body of English engineers, that the matter would not be considered unless brought before them officially. The committee asked for and, by vote, obtained power to continue their work in the name of the society.

It seems probable that the fact that some European countries employ the metric system, while we do not, may stand in the way of the adoption of an international gauge or system, and, in fact, Dr. Egleston stated that both the .001 part of an inch and the .01 of a mm. had been advocated in committee.

After the reading of a paper, which will be reprinted in full in these columns, and need not be further referred to at this time, Mr. F. A. Scheffler's paper describing an instrument by which curves or arcs of circles of any required radius may be drawn, was presented by the author. The instrument is the invention of Mr. Theodore Scheffler, and embodies in convenient form principles which have been before made use of for a similar purpose by wood-workers and others. Two straight-edges are hinged together at the center, and carry at their intersection a pencil or pen; the angle at which these straight-edges are set determining the radius of the circle or arc drawn, when passed over two pins fixed in the drawing-board. A worm and segment, with micrometer graduations, give facilities for setting to a single minute of arc.

Mr. Fred W. Taylor's paper, entitled "Notes on Belting," was then taken up, and was presented by the author. It gives a record of experience with belts used in a machine shop which was in charge of the author, who had arrived at some conclusions considerably at variance with ordinary practice in such matters. Basing his statements upon least trouble, delay and expense caused by belts, the author stated as one of his conclusions, for instance, that "the number of square feet of double belt passing around a pulley per minute required to transmit one horse-power is 80 to 90," which allows almost twice as much belt for a given power as is ordinarily considered satisfactory. Another conclusion arrived at was that faces of pulleys should be about 25 per cent. wider than the belts, which is more than most engineers would consider necessary or advisable where some attention must be paid to room upon the shafting and to reducing the weight as much as possible. Friction clutches were unqualifiedly condemned, and a preference expressed for shifting belts instead, the author stating in discussion that he had tried about all the leading varieties of friction clutches and found them very troublesome. Some of the members in discussing the paper said that its principles would not apply to cases which they cited, and the author said it was not intended to lay down a uniform rule, but only to give the conclusions that were reached in the particular case cited, leaving these to be taken for what they were worth, and applied or departed from in any given case as might seem advisable.

As a record of actual performance of belts under working conditions, the paper was recognized as a valuable one.

Prof. R. C. Carpenter's paper, "Some Experiments on the Effect of Water Hammer," was then presented by the author. Details of tests were given using an indicator to record pressures. The indicator and water tap were attached side by side to a small water main of $1\frac{1}{2}$ inches internal diameter, the static pressure in which was about 30 pounds per square inch. The time taken to close the valve did not exceed $\frac{1}{100}$ of a second. An air chamber was on the pipe, this, in some cases, being partially filled with air, and in others entirely filled with water. The water tap used was $\frac{1}{2}$ inch, and the diagrams produced showed that the maximum pressure was, roughly speaking, about $2\frac{1}{2}$ times the static pressure.

WEDNESDAY MORNING'S SESSION.

The first paper on the programme for this session was Professor Carpenter's "Constants for Correcting Indicator Springs that Have Been Calibrated Cold." It was shown by tests that some indicator springs were undoubtedly calibrated cold, for though when tested cold they gave nearly or quite correct results, when heated to about the temperature they would be subjected to in actual use, they would give results varying by as much as 3.6 per cent., and calculations made showed that this agreed very closely with what they might be expected to do, the calculations showing that the variation between a cold and hot test ought to be 3.45 to 3.66 per cent. In discussing the paper, or in answering questions respecting it, Professor Carpenter stated that during some tests made at Cornell, in which a mercury column was used to indicate pressure, the results obtained were so far outside the range of probability as to cause an investigation, and at length it was found that the mercury, which had been purchased at a drug store, and came in a bottle marked "pure," had a specific gravity of about 11, or 15 to 20 per cent. too low. Afterwards wanting a metal which would fuse at a low temperature, they prepared an amalgam of 50 per cent. mercury, the rest being tin and lead, expecting this to fuse at 106 degrees. It was found, however, that this mixture, which was only one half mercury, looked and acted in all respects like mercury, and would readily have been taken for pure mercury, unless particular investigation of it were made, the conclusion being readily drawn that some precautions must be taken to obtain pure mercury for use in determining pressures.

The paper brought out considerable discussion on indicator springs, and the method of making and calibrating them, several men being present who had had considerable experience bearing upon the matter. Mr. Chas. T. Porter gave his experience in making indicator springs 30 years ago in London. Their practice at that time was, to first have the springs made by a man whom he referred to as extraordinarily skillful, they were then prepared at the ends for proper seating, and were calibrated by weights attached to a rod which passed through the spring and block upon which it rested; a scale below showing the calibration. The final adjustment was made when the springs had just been removed from boiling water and were thus at very nearly the temperature they were subjected to when at work.

Mr. Chas. W. Barnaby, related his experience in making springs for the Thompson indicator when they were first made, these being, as Mr. Porter declared, the first indicators made in this country that could lay any claim whatever to accuracy. They had found it necessary to "jig" the springs, *i. e.*, put them in a machine which compressed them rapidly — about 1,200 strokes per minute. The result of this was to weaken the spring, but the maximum weakening effect was reached in most cases by a treatment lasting one minute, their practice being, however, to keep them in the machine about two minutes. It was found also that allowance must be made for the temperature to which the spring must be submitted when at work, this amounting to about 2 pounds in 40.

Mr. T. R. Almond said that in coiling tempered steel wire he had found in many instances that wire that could not be wound on a given arbor could be easily wound upon the same arbor after being laid aside for about six months, this indicating to his mind that steel wire might require time for adjustment of its molecules with respect to each other, by which adjustment internal strains were relieved and the wire arrived at its normal or relatively permanent condition.

Mr. A. A. Cary, who has had experience in the manufacture of springs upon a large scale, called attention to the importance of coiling the wire in the same way as it was coiled when made, and said that it sometimes happened that wire could be coiled successfully in no other way. He also said that the variations in the readings when the same weights were applied to the springs, as between a movement of extension and one of compression just previous to the reading, as shown in the diagrams given in the paper, was the result of a characteristic of all helical springs, which he attributed to molecular action, comparable with taking up slack in a chain or in mechanism; that is to say, the molecules must needs adjust themselves upon each other slightly with each change of direction of their movement before the normal resistance to this movement could be set up.

The next paper also related to the use of the indicator, but consideration of it is deferred until its publication in these columns which will follow.

The next paper was by Professor Carpenter and described a new form of Prony brake, the distinguishing feature of which is a closed copper tube of oval section which is placed outside the pulley and inside a steel band which encircles it and prevents its enlargement. Connections are then made to water pipes in such a way that water is made to flow through this tube, and any desired pressure can be obtained by adjustment of valves in the pipes, this pressure acting to vary the load upon the engine at the will of the operator.

The final paper of this session was by Prof. D. S. Jacobus, and showed that indicator cards taken simultaneously with different indicators so attached as to receive the same pressure, were, after all proper corrections had been made, practically alike.

Topical questions were then taken up, the first of these relating to the best method of determining the power developed by an engine subject to very great and violent fluctuations of load as in rolling-mill service, and in particular whether continuous cards, or cards taken at regular intervals were best. This question seemed unsettled at the end of the discussion, during which Mr. Fred Low stated that he had had an indicator provided with a planimeter wheel at the end of the lever in place of the usual pencil; this when allowed to work continuously for a time showed the aggregate area of all the cards that would have been drawn had the regular pencil been used. It worked well with a slow running engine, but not at high speeds.

The next question: "Does copper undergo a change from prolonged service which renders it unsafe after awhile to carry high-pressure steam in pipe or expansion joints, etc.?"

Mr. Henning said that some investigations had recently been made in Europe on this question that seemed to indicate that such a change did take place, but the matter referring to it had not yet been published. Mr. Durfee suggested that it might be important to know in every case whether what was being tested or used for a steam pipe was really copper or a mixture of copper and other things, such as arsenic, for instance, as this might very materially affect the question.

The next question was, "How far can hydraulic (or other) pressures be advantageously substituted for the drop-press, in the manufacture of small stamped metal articles, either by hot or cold treatment, especial regard being had to the making of plated wares, and to the cost of maintaining the forming dies?"

Mr. Kent stated that he had made some calculations upon the basis of an embossed surface $\frac{1}{2}$ inch deep, using a 200-pound drop of 50 inches, which would correspond to a pressure of about 80,000 pounds; and a hydraulic press, therefore, to do the same work would have to exert this pressure, and would be much more expensive to buy and maintain. Mr. Durfee said that he had been informed by a man of large experience in making drop forgings, that the air confined between the metal and the surface of the dies, and forced out under great pressure as the die filled, did more than any other one thing to score and injure dies, and that means taken to prevent this proved very beneficial.

The next question: "What is the best mode for packing the rods and plungers of hydraulic machinery, particularly under high pressures?" brought out considerable information on this subject which can better be presented at some other time.

The usual formal reception was tendered the members and their friends Wednesday evening at Sherry's, and was a very enjoyable affair, participated in by a large number of people.

THURSDAY'S SESSION.

The first thing that occurred at Thursday morning's meeting was a departure from the programme, Professor Thurston having been requested to formally present to the society on behalf of H. H. Suplee an oil portrait of Prof. Francis Reuleaux which had been painted by Miss Suplee, the sister of the donor. In making the presentation address, Professor Thurston paid a very high tribute of praise to Professor Reuleaux as an engineer, educator and economist, declaring that he was the world's leader in matters pertaining to engineering education, and had founded and built up at Berlin the noblest school in Europe devoted to scientific education. Professor Reuleaux was also the most eminent and most appreciative representative of the society in Europe. But aside from Professor Reuleaux's eminence as an engineer and teacher, he was still more to be admired by those who knew him as a man, the speaker basing this opinion upon a personal acquaintance dating from the Vienna Exposition where the two had been associated in official duties. Professor Thurston's address was a model, and that it was appreciated was shown by the applause which it called forth, which was renewed when the portrait, which up to this time had hung draped upon the east wall of the auditorium, was uncovered, and the excellent likeness brought to view. President Coxe responded on behalf of the Society, alluding in the highest terms to Professor Reuleaux's services to engineering, and stating that it was almost impossible to read engineering literature, or to take part in discussion of engineering matters without finding reference to Professor Reuleaux's work or making use of it. He was pre-eminently a teacher of teachers, and possessed the faculty in an unusual degree of combining deep theoretical knowledge with that practical turn which enabled him to apply this to practice, and to thoroughly grasp the importance and value of such practical matters, for instance, as the general use of micrometer calipers by American machinists, to which he alluded in his Chicago address.

Mr. H. L. Gantt's paper, "Recent Progress in the Manufacture of Steel Castings," was then presented by the author The paper referred to the fact that but a few years ago steel castings consisted of about equal parts of steel and holes. From this condition the progress of the art was traced to the present time at which steel castings must stand severe tests, and must be nearly as smooth as those of cast iron. The first steel castings made in this country subjected to ballistic tests were made in 1886 and 1887 by the Midvale Steel Company, who were the pioneers in this work. Hot metal had been shown to be of prime importance in making such castings sound and homogeneous, and this hotter metal, with castings of larger dimensions, had forced the improvement of the materials employed for molds, the present practice being to use silica sand and molasses thoroughly ground together.

The paper closed with a reference to a patented method of placing within the mold at any desired point or points, linings of a metallic alloy in a powdered or crushed state, these being melted and absorbed by the hot steel poured into the mold, and changing its characteristics, so that if desired such faces could be made either naturally harder than the balance of the casting, or be made capable of being hardened by the ordinary processes. Ferro manganese was used for the first, and ferro chrome for the second purpose.

Mr. Durfee, in discussing the paper, expressed the opinion that as good results had been obtained in the earlier practice of steel casting when he himself was connected with the Midvale Works as at any later period, it being shown, however, that the earlier castings were of crucible steel relatively high in carbon, and poured at much lower temperature than the later Bessemer or open hearth steel lower in carbon.

Mr. William A. Pike's paper, "Steam Piping and Efficiency of Steam Plants," was next presented. It stated the commonly recognized requisites of a first class job of piping, and gave some instances in which a rearrangement of piping had resulted in considerable improvement. This paper called out a great deal of discussion—so much that but one other paper could be presented at the session, three papers being deferred. The discussion was mostly illustrated by blackboard sketches, which would have to be reproduced in order to give an intelligent idea of it. President Coxe—in giving an account of their practice at Drifton—said they made comparatively little use of expansion joints, as they had found that in a system of piping no part expanded so little as the expansion joints. They bent their pipes at the terminals, and sometimes in the middle of long lengths, to a radius of about 10 feet (this up to 6-inch pipes) and made an especial point of using a large receiver at the engine, into which the pipe entered and from which the engine or pump drew its supply.

FRIDAY'S MEETING.

At Friday's meeting the papers deferred from the previous day's meeting were taken up, one of these being that of Prof. R. C. Carpenter, giving results of some experiments to determine the effect of water in steam upon the efficiency of the steam engine.

The results are tabulated, and the experiments showed that whatever the percentage of water in steam within the range of the experiments the consumption of dry steam remained constant, and that the water had no effect whatever in the engine other than that of an inert substance, the engine being an experimental one with very large clearance spaces, making it possible to use steam containing larger percentages of water than would be safe with any ordinary commercial engine. The wet steam seemed simply to raise the entire diagram—equally in all its parts. The discussion seemed to show that most of the engine men rather expected that this would be the result of such experiments, and it was in fact brought out that Prof. James E. Denton had made some experiments of a similar nature which showed the same results, these having been presented at a meeting of the American Association for the Advancement of Science in 1888.

Mr. F. A. Scheffler's paper, "Test of a Boiler Using Grates with a Small Percentage of Openings," was then presented by the author. The test was of a Stirling boiler which had grate bars of herring-bone type with 15 per cent. openings, which though considered to be much too small were found to be ample, notwithstanding the boiler was crowded considerably beyond its normal rate of evaporation.

The paper brought out a great deal of discussion, as is always the case with papers that may involve the relative merits of different boilers. Mr. Cary thought that in view of the fact that no calorimeter test was made it was probable the satisfactory evaporation attained was due to wet steam, and a good deal of the water fed to the boiler going over unevaporated. Mr. Scheffler replied that though no calorimeter test had been made in this instance, other tests made under similar conditions of forcing had shown that the steam furnished by these boilers was practically dry. Mr. Cary described an apparatus used by him in a case where there was an inadequate chimney. He had put in an exhaust fan which was driven through the medium of Evans' friction cones, the speed being thus automatically controlled by the steam pressure acting upon a counterweighted piston. By a mistake of a clerk, new grate bars were ordered with $\frac{5}{16}$ inch instead of $\frac{5}{8}$ inch openings. The automatic device then ran the fan near its maximum of 1,000 revolutions instead of near its minimum of 200 revolutions as before, showing that what was virtually more chimney was required for the small grate openings. Mr. Kent thought the main choke of draught occurred in the body of the fuel in any event, and that it was better to provide ample openings as a provision against partial obstruction by clinker or otherwise.

Some remaining papers were presented which will be taken up by us later, and topical questions were then considered. One of these was, "What are the maximum safe speeds for hoisting and traversing in an overhead traveling crane in a machine shop?" Wm. O. Webber thought the speeds of Shaw electric cranes in use in the shops of the Pond Machine Tool Works were about the maximum, and these were: travel of bridge 400 feet per minute, of trolley 200 feet and hoisting 50 feet.

In reply to the question "Will a forced circulation of air under a floor near the ground prevent decay of the woodwork and floor timbers?" Mr. C. J. H. Woodbury gave an instance in which such forced circulation had stopped the sweating which

causes decay when the mere provision of the usual openings had failed to prevent this. Mr. Robert Cartwright had prevented decay of 16-inch timbers used in wheel pits by boring through the timbers lengthwise an inch hole, and providing for free access of air at each end of this. He said it was to be noted that a timber decidedly wet would last longer than one exposed merely to a damp atmosphere. Mr. Durfee said that all timbers entering masonry walls should have a clear space at their sides for ventilation, else they would be apt to decay within the walls.

To the question, "Have you any facts to show that there is a molecular change in metals when their temperature is raised or lowered?" Mr. W. L. Cheney replied that a firm making straight-edges of hardened steel had found that by drawing these to a straw color after hardening, they secured as great permanency of form as would otherwise be obtained by a very long period of "seasoning," *i. e.*, laying aside to allow for molecular adjustment. Mr. Cary instanced the case of the lower tubes of water-tube boilers, which were gradually lengthened from the effect of heat, and sometimes caused trouble.

To the question, "Which is the best process to repair old files—sand-blasting etching, or recutting?" Mr. Henry L. Binsse replied to the effect that it did pay to have them recut twice if the files were originally good ones, and that these good ones were the only kind of files that it paid to buy in any event, and he gave some cases from his experience to prove it. He said that first-class files properly recut were as good as new, and reduced file bills about 30 per cent. Others, however, thought the best way to repair old files was to throw them away and get new ones.

The question, "Is there any reason why diametral pitch should not be used for very large gears, instead of circular?" brought out some reasons which, so far as any one could see, would apply equally to either system of computing pitch, and one at least of those discussing it seemed to overlook the fact that fractional diametral pitches may be used as well as integral.

The question, "What experience have you had with iron cores or chills for straight holes of ⅜ inch diameter to 3 inches through 1½ inches thick upwards?" brought out from Mr. F. H. Richards, of Hartford, his experience with copper for this purpose, which he had found much superior, as it conducted the heat away more rapidly, first expanded more, and then contracted more, making the chill loose and easily removed, and finally was much more durable. It would not do, however, for large castings, as the long continued heat from these melted the copper.

Officers elected for the ensuing year are as follows: President—Eckley B. Coxe, Drifton, Penn.; Vice presidents — C. E. Billings, Hartford, Conn.; Percival Roberts, Jr., Pencoyd, Penn., and H. J. Small, Sacramento, Cal.; Managers—John B. Herreshoff, Bristol, R I.; L. B. Miller, Elizabeth, N. J., and W. S. Russell, Detroit, Mich.; Treasurer—William H. Wiley, New York; Secretary—F. R. Hutton; Assistant Secretary—Francis Hoadley.

The Paris, Lyons and Mediterranean Company has still further developed its express engines since a specimen was exhibited at Paris in 1889, and duly described and illustrated in *The Engineer*. The new locomotives are lighter than the old, weighing in running order 48 metric tons, with an adhesion of 30 tons. At the same time the diameter of the cylinder has been slightly increased, while the boiler capacity has also been increased by adding 6 cm., or 2⅜ in., to its diameter. The tube surface has been increased by the adoption of tubes with internal ribs, as already used in marine boilers, the total heating surface being thus raised to 148 square meters, or 1,592 square feet. The new engines, which are fitted with bogies for greater stability and more easily running round curves, will make the 863-kilom. = 536 mile run between Paris and Marseilles in 11 hours instead of 14½ hours, as at present.—*The Engineer*, London.

MANUFACTURES.

The Hercules Iron Works, Aurora, Ill., have started.

E. C. Wehrfritz, of Little Rock, Ark., will rebuild his machine shop.

An addition is being erected to the Ellwood City (Pa.) Tube Works.

The 16-inch mill of the Indiana Iron Co., Muncie, Ind., has started.

Work has been resumed at the Mambourg Glass Works, Fostoria, O.

The Spearman furnace at Sharpsville, Pa., has started with 800 men.

The Eureka Steel Casting Co., Chester, Pa., is erecting an addition.

Ludom's Carpet Works at Bristol, Pa., have been started with 600 hands.

The Rosena furnace at New Castle, Pa., has been put in operation.

The burned portion of the Bath (Me) Iron Works will be reconstructed.

No. 2 rolling-mill of the Cambria Iron Co., Johnstown, Pa., has started.

All the glass works at Muncie, Ind., eight in number, are now in operation.

John F. Fleming will build a mill on one of his water-powers at Winn, Me.

Hayden Bros., Mechanic Falls, Me., are building an addition to their foundry.

The Phoenix Plate Co. is erecting an addition to its works in Worcester, Mass.

Furnace No. 1 of the Burden Iron Co., of Troy, N. Y., has again been started.

A stationary steam-mill for the manufacture of lumber is to be built in Solon, Me.

It is reported that the Irondale Rolling mill Co., of Anderson, Ind., will rebuild its plant.

Nearly the entire plant of the Rome (N. Y.) Locomotive Works has been destroyed by fire.

A branch shop of the Holland Radiator Co., of Bremen, Ind., will be erected at Avonmore.

The Glade Axe and Tool Works, of Warren, Pa., are to be reorganized into a stock company.

The Edgar Thomson Steel Works at Braddock, Pa., employing 800 hands, have resumed work.

The recently burned F. A. Thomas Machine Works at Woonsocket, R. I., will be rebuilt.

The San Marcos (Tex.) Electric Light and Power Co. has recently increased its capital stock.

The Quimby Brush Co. has been organized in Boston for the manufacture of machine brushes.

The shops of the Pennsylvania Railroad Co., Walls Station, Pa., have begun work on full time

After a long idleness the Cleveland Rolling-mill Co., Ohio, has started up on an order for structural iron.

The Niagara Radiator Co. has recently broken ground for its new plant at North Tonawanda, N. Y.

The Wheeling Steel and Iron Company, employing about 500 men, started its Benwood Mill Dec. 4th.

The Erie & Pittsburgh Railroad Co., at Erie, Pa., has put the entire force on ten hours a day at its shops.

A new industry, the manufacture of bicycles, is to be started in Manchester, N H., by the J. B. Varick Co.

The Cleveland Rolling-mills Company's sheet and puddle mills have started up after an idleness of five months.

L. S. Starrett has completed an addition to his tool shop in Athol, Mass., that more than doubles its capacity

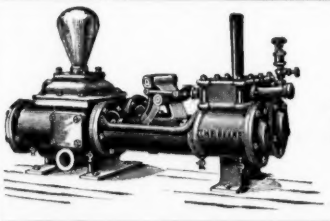
The H. K. Porter Machine Co., Pittsburgh, Pa., will build a brick machine shop, 72x135 feet, at a cost of $18,000.

Work is progressing rapidly on a new fish-plate-mill being built at Duquesne, Pa., by the Carnegie Steel Company.

Rice, Barton & Fales, Worcester, Mass, making paper machinery, have moved into their new and improved plant.

The Shetucket Mill, Norwich, Conn., which has been running with half its force, has started up with full force, 600 hands.

The Parkhill Manufacturing Company's mills employing 1,200 operatives, at Fitchburg, Mass. has started up on full time.



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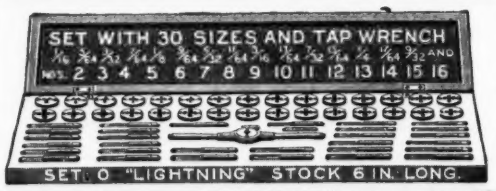

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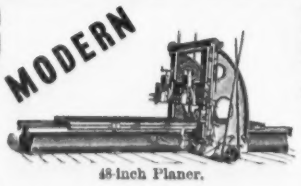
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The Newport News (Va.) Ship and Dry Dock Company has been awarded the contract for two gunboats at $280,000 for each vessel.

The Baldwin Locomotive Works, Philadelphia, Pa., have received an order from the Atchison, Topeka & Santa Fe system for 72 locomotives.

The Columbian Textile Co., of Philadelphia, Pa., has been formed with a capital of $25,000. The incorporators are: H. N. Booz, Henry W. Hiller.

The stockholders of the Toronto (O.) Pottery Co. at a recent meeting made arrangements to take the pottery out of the hands of the receiver.

The Buffalo (N. Y.) Gas Saving Co. has been formed to manufacture a gas governor. Capital, $10,000; and directors, S. S. Vosburgh and E. M. Smith.

It is stated that the Pittsburgh Plate-glass Co. has released its employes at Ford City, Pa., from payment of house rent for the months the works were idle.

E. G. Smith, Columbia, Pa., informs us that he has just finished fifty of his latest vernier sliding calipers for the Franklin Educational Co., of Boston, Mass.

The roof for the new purifier house of the Northern Liberties Gas Co. is now being put in place by the builders, the Berlin Iron Bridge Co., of East Berlin, Conn.

The pay-roll of the Exeter (N. H.) Boot and Shoe Co. last week was $2 500, and appearances indicate that it will soon be increased to the usual amount, $4,000 weekly.

The Raney & Berger furnace, the only one idle at New Castle at present, is getting ready to blow in. The metal made will be used by the New Castle Steel Company.

The saw-mill at Mosher Pond, in Fayette, Me., owned by Clark & Conant, the Auburn shoe-box manufacturers, was recently burned. The fire caught from the boiler.

In Watertown, N. Y., several of the manufactories which have been shut down during the past two months on account of the financial depression, have resumed operations.

The Watson Machine Co., Paterson, N. J., issue a catalogue of binder twine machinery. This machinery is made from improved patterns, and is very neatly illustrated in the catalogue.

Charles Cooper's Machine and Needle Works, Bennington, Vt., issue a very complete illustrated catalogue of machinery for knit goods, which manufacturers will find of interest.

The construction department of the Philadelphia Bridge Works, at Pottstown, Pa., has resumed operations on double turn, and the nail-mill of the Pottstown Iron Co. has started 20 machines.

A temporary factory is being erected for Clark Brothers & Co., Hartford, Conn., whose bolt works were burned a short time ago. In the spring a new factory will be built near the Milldale depot.

The skelp and bar-mill of the Montour (Pa.) Iron and Steel Co., of Danville, Pa., has resumed operations after an idleness of eight months. The puddling department of mill No. 1 is in full blast.

A Wheeling (W. Va.) dispatch of December 4th says: The entire sheet-mill department of the Etna Standard Iron and Steel Company, at Wheeling, employing 1,500 men, will start on full time to-day.

The Carpenter Steel Works, of Reading, Pa., which has been busy on government contracts several years, has received another contract for seacoast defense projectiles, which will keep the works busy two years.

The Thomson-Houston Co., Lynn, Mass., has 150 men at work in the meter department at Lynn. The company says that all its departments will be running soon. The men in the meter department will work 55 hours a week.

The Carnegie Steel Company is pushing the new addition to its armor plate press works, at Homestead, Pa., rapidly to completion. The big hydraulic press and other enormous castings have arrived from England and are being put in place.

The Hammond Buckle Company, of Rockville, of which Samuel A. Chapman, of Waterbury, Conn., is president, has bought the plant of the Chapman & Armstrong Manufacturing Company at Waterbury, and will move the business there.

John McIlroy & Sons have resumed operations in part of their Annabesacook woolen mills, North Monmouth, Me. During the suspension a new boiler house and tower have been added, automatic sprinklers introduced, and other improvements made.

We have from the Detroit Foundry Equipment Co., Detroit, Mich., an illustrated catalogue of the Whiting cupola, which they manufacture in twelve sizes; also copies of a number of letters from users of these cupolas, in which they are highly praised.

A Burlington (N. J.) dispatch says: The shoe industry here has taken a big boom, and all the factories, which have been doing apparently nothing for the last three months, have started up on full time. This city manufactures millions of dollars' worth of shoes during the year.

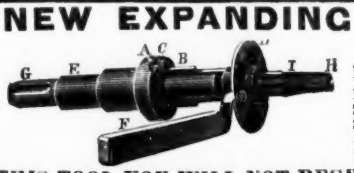
Ground has been broken near Saltsburg for a new sheet plant to consist of four mills. Among those interested are Anderson Gourley, manager of the P. H. Laufman's mill at Apollo, and Dr. Leech of the same place. The capital is said to be $50,000, of which about $35,000 will be used for the construction of the mill.

A Pittsburgh (Pa.) dispatch says: Local tanneries employing many hundreds of men, which have been idle since early summer, as a result of the general trade stagnation, are resuming. Two large tanneries have resumed in full and others are active in preparation. The prospect for the tanneries here has greatly improved.

There are excellent reasons for stating that the Walter A. Wood Mowing and Reaping Machine Works at Hoosick Falls will be in full operation about December 15th or 20th, with the usually large force of employes. The malleable works are in operation preparatory to the resumption of work in the other shops.—*Troy Times.*

LECOUNT'S NEW EXPANDING MANDREL.

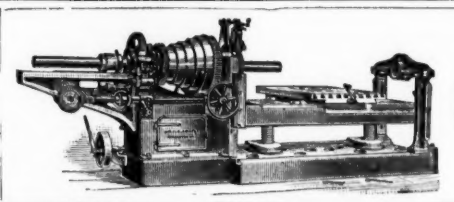
Amateur's Size.
Taking anything from ⅛ to 1 inch inclusive.
Price.....$5.00
Patented Dec. 25, 1877.



Machinist's Size.

No.			Price.
1	⅛ to 1	in.	$10
2	1 "	1½ "	14
3	1½ "	2 "	18
4 (with screws)	2 "	3 "	32
5 " "	3 "	4 "	44

IF YOU WILL TRY THIS TOOL YOU WILL NOT REGRET THE EXPENSE.
C. W. LECOUNT, SOUTH NORWALK, CONN.
SPECIAL MANDRELS FOR SPECIAL JOBS MADE TO ORDER.
These goods are for sale by CHAS. CHURCHILL & CO., L'td, 21 Cross St., London, England.



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VARIETIES FILES
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GRANT GEARS
Ready Made Cut Gears.
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Gear Book, 15 cents.
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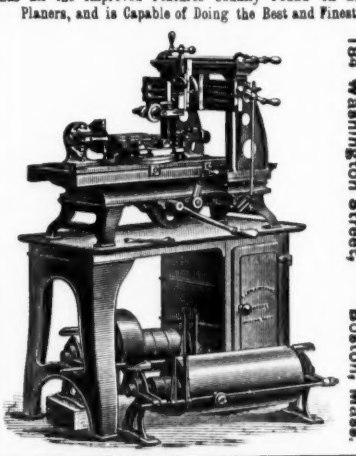
POWER OR HAND PLANER,
FOR MODEL MAKERS, EXPERIMENTAL WORK, &c.
Has all the Improved Features Usually Found on High Grad Planers, and is Capable of Doing the Best and Finest Work.



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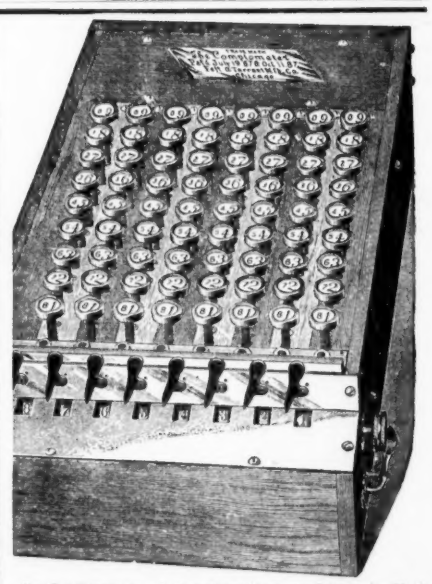
A. J. WILKINSON & CO.,
184 Washington Street, Boston, Mass.



In the Bureau of Construction and Repair, U. S. Navy, the Comptometer is used for 95% of all arithmetical work. Assures accuracy, rapidity and ease. Bridgeport Machine Tool Works, Bridgeport, Conn., write: "It has become almost indispensable in making up our weekly pay-rolls and cost accounts."
Waterbury Watch Co., Waterbury, Conn., writes: "It helps to do much in little time and do it easily." Write for pamphlet.
FELT & TARRANT MFG. CO., CHICAGO.

THE BERLIN IRON BRIDGE CO.

Office and Works:

No. 8 Railroad Ave., East Berlin, Conn.

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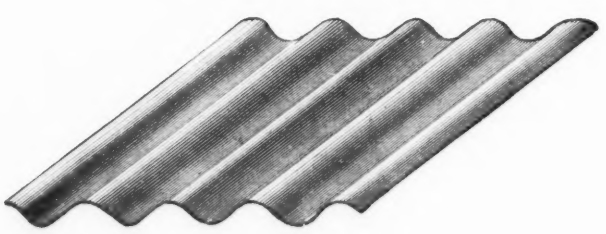
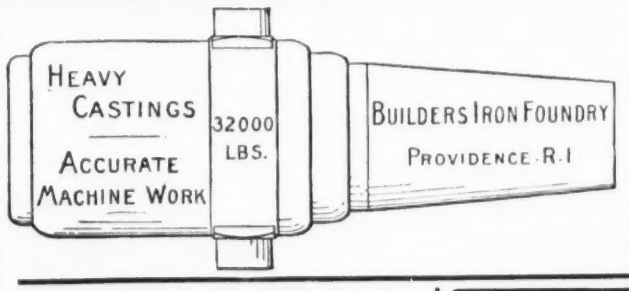


IRON AND STEEL BRIDGES AND BUILDINGS.

We are prepared to furnish Corrugated Iron painted both sides, all sizes and gauges. Our oil finished Corrugated Iron is superior in lasting qualities to any in the market.

SEND FOR OUR ILLUSTRATED CATALOGUE.



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Second-Hand Machinery FOR SALE.

1 24 in. swing, 25 ft. bed Engine Lathe.
1 3 in. Cutting-off Machine.
1 Lincoln Pattern Milling Machine.
1 15 Horse Horizontal Engine.
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1 25 Horse Locomotive Boiler.
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Several smaller Roots' Blowers, all in first-class condition. For full particulars address,

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A FOX TRIMMER
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OVER 7,000 SOLD.

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LATHE
Screw Cutting Automatic Cross Feed, etc.
Scroll Saws, Circular Saws, Lathes Mortisers.
LATHE
Catalogue Free of all our Machinery.
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FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM JESSOP & SONS, LTD.
Established a century ago.
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WORTHINGTON STEAM PUMPS
FOR ALL DUTIES.

HENRY R. WORTHINGTON,
NEW YORK,
BOSTON, PHILADELPHIA, CHICAGO,
ST. LOUIS, DENVER.

"Business is rapidly improving with us," so says the Penberthy Injector Co., of Detroit, Mich. They add that their November sales are nearly double those of October, and that they are again running on full time and with a full force.

Builders' Iron Foundry, Providence, R I., issue a folio giving some idea of what they manufacture in the way of the venturi, meter, heavy rifled mortars for the government, hot air engines, etc., with some account of their exhibit at the Columbian Exposition. This firm have special conveniences for making ordinary and heavy castings, general or special, air furnace and loam work, etc., and have heavy machine tools for finishing work. They have done some notable architectural work, and give particular attention to difficult chilled work.

Machinists' Supplies and Iron.

NEW YORK, December 9, 1893.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $14.00 to $15.00; No. 2, $13.50 to $14.25; Gray Forge, $12.25 to $12.50. Southern brands of good quality are obtainable at $13.00 to $14.00 for No. 1 Foundry; $12.00 to $13.00 for No. 2, and $11.25 to $12.00 for Gray Forge.

Antimony—The market is quiet and easy with a tendency towards lower prices. We quote L. X., 9.65c. to 9.70c.; Cookson's, 9.95c. to 10c.; Hallett's, 9c. to 9.05c., and U. S. French Star, 10c.

Lard Oil—Prime City is quoted at 72c. to 74c.

Copper—The market is steady. Lake Copper is quoted at 10.40c. Casting Copper is held at 9.60c. to 9.75c

Lead—The market is extremely dull with 3 20c. asked and 3 10c. the best bid.

Spelter—The market has a firmer tendency, the ruling quotations are 3.85c. asked, and 3.75c. bid for spot.

Tin—The market is barely steady at 20.50c. to 20.60c. for December and January delivery. The demand is extremely light.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Comp. draftsman, college grad., exp'd in eng. and boiler work, wants steady pos. O. K., AM. MACH.

Draftsman, exp'd in mach. tools, jigs, fixtures, and gen. mach'y, desires pos. M., BOX 76, AM. MACH.

Situation Wanted—By steady practical pattern maker and draftsman, age 33. P. D., AM. MACH.

A1 experienced mach. draftsman wants position January 1st. Address Thorough, AM. MACHINIST.

A young man, tech. grad., with experience in erect'g & test'g auto. eng., erect'g locomotives, des. pos. as draftsman; good refs. Box 140, AM. MACH.

Wanted—Position in small job or mfg. shop as foreman or mechanic by young man with push. Address BOX 139, AMERICAN MACHINIST.

First class man wants situation as foreman boiler maker or layer out; used to handling a large body of men; references A1. A. F., 84 Meserole Avenue, Brooklyn, N. Y.

Sup't Wanted—A large jobbing foundry having a capacity of 40 tons per day and running principally on architectural cast-iron work desires to secure the services of an experienced superintendent; must thoroughly understand the practice and economical production of heavy and light castings by the most modern foundry practice; must understand the mixing of iron and be competent to figure on work; to the right man, who can take general charge, we can offer extraordinary inducements, and will, as soon as ability is demonstrated, give interest in the business. Address Columns, care AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S. M. York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz. Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Wanted—Engine lathes—2d-hand in good order, 1 each, 24"x12', 28"x12', 32"x12'. Box 136, AM. MACH.

Agents—$5 Speed Gage, new, valuable, sells; shows constantly speed and slightest variations; Geo. T. McLauthlin & Co., 120 Fulton St., Boston.

Speed lathes, stiff, powerful, large hollow spindles, milling lathes, remarkably serviceable machs. W. H. Mansfield, 71 Court St., New Haven, Conn.

Wanted—To buy second-hand screw-cutting lathe to swing 20 inches over rest and turn 12 feet between centers: universal chuck, center rest, tools, etc. H H Childs, Rockford, Mich.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

To Inventors—A brass f'd'r finisher and elec'plater, having best mach'y and abundant power with highly skilled workmen, desires additional small metal specialties to m't'ture; elect'l applian's a spec'y. Menlo Park Mfg. Co., 4 E. 13th St., N.Y.C'y.

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Corner Lake & Kirtland Sts., Cleveland, O.
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SPECIAL LIST—SECOND-HAND
Machine and Boiler Tools.
MODERN STYLE. GOOD ORDER.
WILL BE SOLD LOW.

Blaisdell Engine Lathe, 13 in. x 6 ft., complete.
Fitchburg " " 14 " 8 " "
Hendey " " 14 " 6 " Taper at'chm't.
Ames " " 16 " 8 " Reverse Motion.
Bridgeport " " 16 " 7 " Complete.
Hendey " " 18 " 10 " Compound Rest.
Putnam " " 20 " 8 " Complete.
Putnam " " 24 " 12 " Compound Rest
Improved " " 36 " 14 " Complete.
New Haven Planer, 20 in. x 5 ft. "
Whitcomb " 20 " 4 " "
Freeland " 24 " 8 " "
Pond " 30 " 8 " "
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Gould 8 in. Shaper. Crank Motion.
Prentiss 12 in. " " "
Hendey 15 in. " Friction.
Improved 15 in. " Crank Motion.
Ames Upright Drill, 24 in. Back Gears, Auto. Feed.
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Brown & Sharpe Vertical Turret Mkg. Mch. 36 in
Upright Boring and Turning Mill, 38 in., 2 Heads.
Lincoln Milling Machine.
Improved Universal Milling Machine.
Brown & Sharpe No. 5 Screw Machine.
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Boiler Bending Rolls, 10 ft., Hinged Housing.
Boiler Punch and Shears, Common Size.

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1 15 in. x 5 ft. Flather.
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2 15 " Juengst, Friction.
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1 10 in. 3-Spindle Slate.
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2 Pratt & Whitney, 4-Spindle.
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1 20 in. Blaisdel, Sliding Head.
1 22 " Prentice, B. G. P. F.
1 24 " Cincinnati, Sliding Head
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1 24 " Prentice, B. G. P. F

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2 14 in. x 5 ft. Fox Lathes. Square Arbor.
1 Whiton 2-Spindle Centering Machine.
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2 36 in G. & E. Auto. Gear Cutters.
2 Garvin Auto. Gear Cutters.
1 6 in. Bement Slotter.
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1 No. 2 Nat. Single Bolt Cutter.
1 " " " Double " "

Also, large variety of other machines. Write for complete list and detail description.

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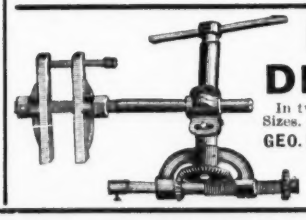
LAIGHT & CANAL STS., NEW YORK.



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In two Styles and four Sizes. Send for circular to
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Builders of WIRE FORMING MACHINES
With F. B. Manville's Patent Sliding Former,

For making articles from the coil, of either round, half-round, flat, or square wire, similar in shape to those shown in the cut herewith. Also similar articles made to order.

Send samples of articles required, and mention quantity wanted, that we may quote prices for either machine or the goods, whichever may be desired.

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EICKEN & CO.'S CRUCIBLE TOOL STEEL
HAGEN, WESTPHALIA, GERMANY.

SPECIAL No. 8, makes a fine finish on the hardest Rolls; Boss Cold Chisel Steel; High Grade Twist Drill, Tap, Punch, Reamer, Wood and Milling Cutter Steel and Blanks.
The **HIGHEST QUALITY**; Inducements to the Trade and large Users.

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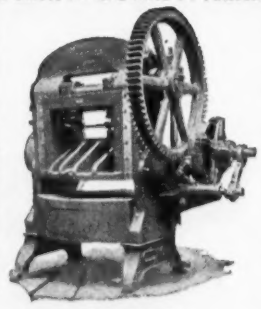

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Fine Machinists' Tools. E. BOSTON, Mass. Send for LISTS

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Any size and face of **Pulleys.** Any size face and pitch of **Gears,** spur, worm or bevel. Address,

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IRON FOUNDERS,
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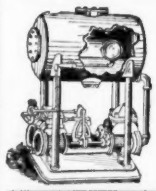

AUTOMATIC FEED PUMPS AND RECEIVERS
For returning hot condensed water to boiler.
STEAM PUMPS FOR ALL DUTIES.
THE BUFFALO STEAM PUMP CO.,
WORKS, BUFFALO, N. Y.
BRANCH OFFICES { 76 JOHN STREET, N. Y. CITY / 55-57 CLINTON STREET, CHICAGO, ILLS.

GRAHAM TWIST DRILL AND CHUCK CO., DETROIT, MICH., U. S. A.
SOLE MANUFACTURERS OF
GRAHAM'S GROOVED SHANK TWIST DRILLS AND CHUCKS.

Endorsed by Practical Mechanics Everywhere. Send for Catalogue.

BOILER AND MACHINE SHOP
MACHINERY
NEW AND SECOND HAND.

Boiler Rolls, 8 ft. 3 in. between Housings.
Punch, 21 in. Throat, with shear block.
Hand Power Boiler Rolls.
Boiler Clamp.
Engine Lathes, from 12 in. to 92 in. Swing.
Planers, " 20 " " 62 " Wide.
Drills, " 16 " " 44 " Swing.
Radial Drill, Hilles & Jones, 48 " Arm.
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No. 0, Am. Tool & Mach Co A1.
Wheel Lathe, 88 in. Swing, with Two Tool Carriages
Quartering Machine, Bement, Double Right and Left Hand.
Stiles Presses, No 4, Fowler No. 0 and 1½.
Pratt & Whitney Screw Machines, No. 1, 2 and 3.
Garvin No. 4 Miller, No. 2 Hand Miller.
Pratt & Whitney No. 3 Hand Miller.
Drop Hammer Dynamo, large lot, Polishing Mchy., Belting, &c.

SEND FOR OUR LATEST LIST.

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IF YOU WANT ANYTHING IN THE LINE OF DROP PRESSES, DROP HAMMERS, STAMPS OR AUTOMATIC DROP LIFTERS.
SEND FOR CATALOGUE TO
Miner & Peck Mfg. Co.
NEW HAVEN, CONN.
LARGEST LINE IN THE MARKET

POWER PRESSES
Adjustable. Improved.
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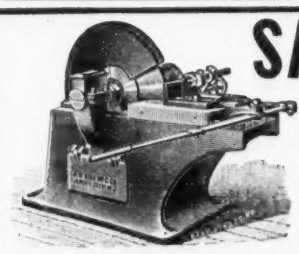

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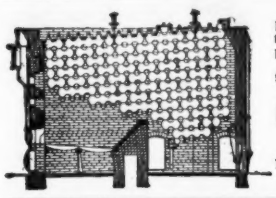

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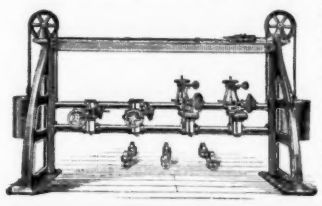

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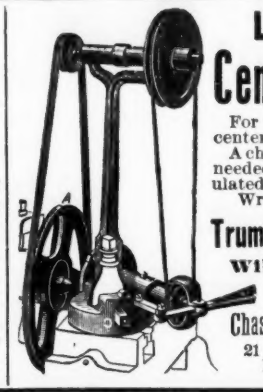

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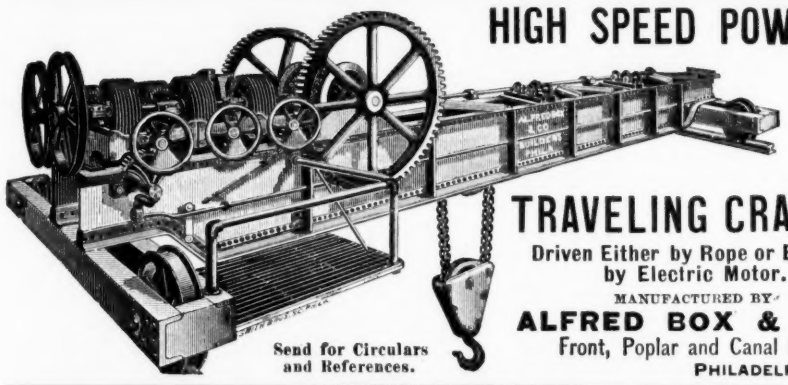

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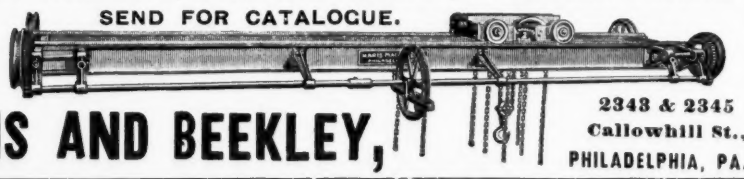

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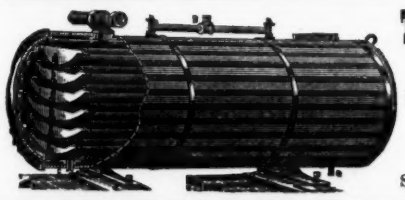

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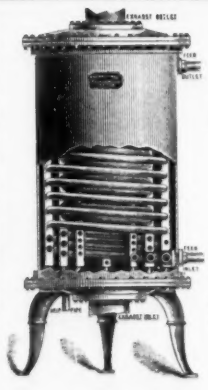

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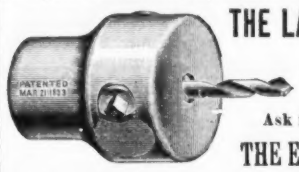

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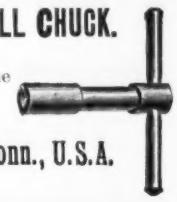

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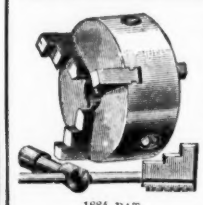

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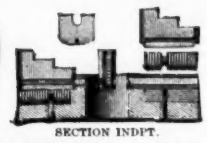

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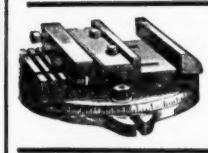

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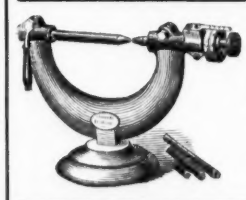

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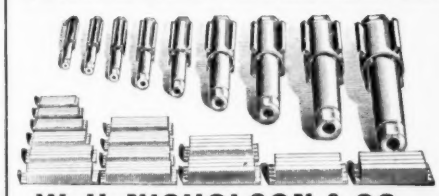

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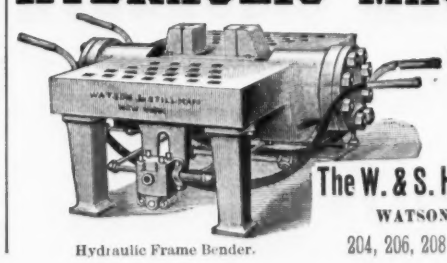

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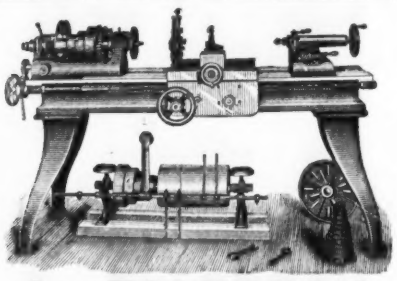

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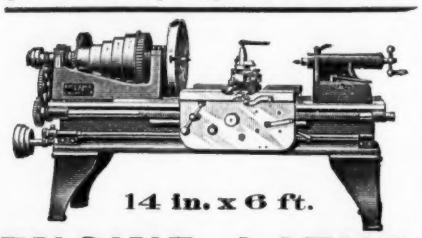

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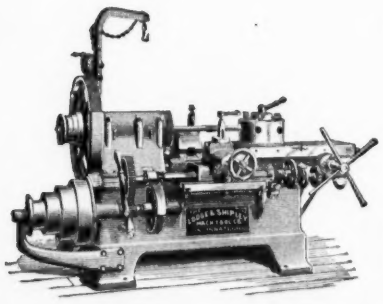

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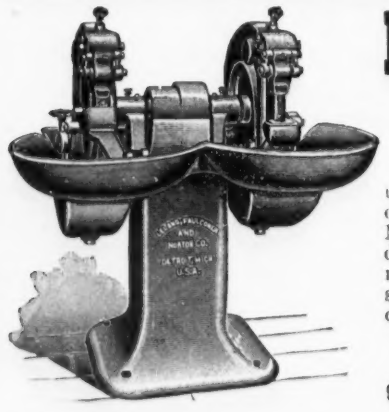

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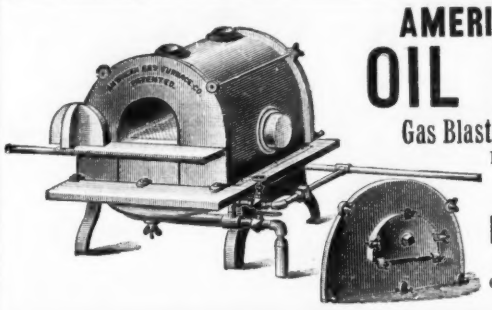

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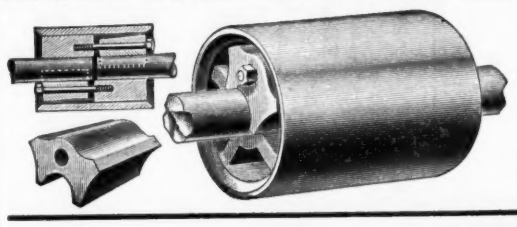

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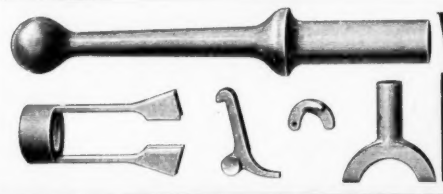

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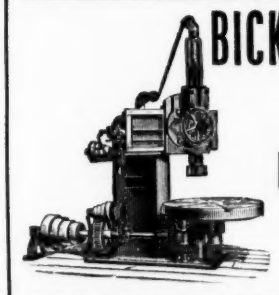

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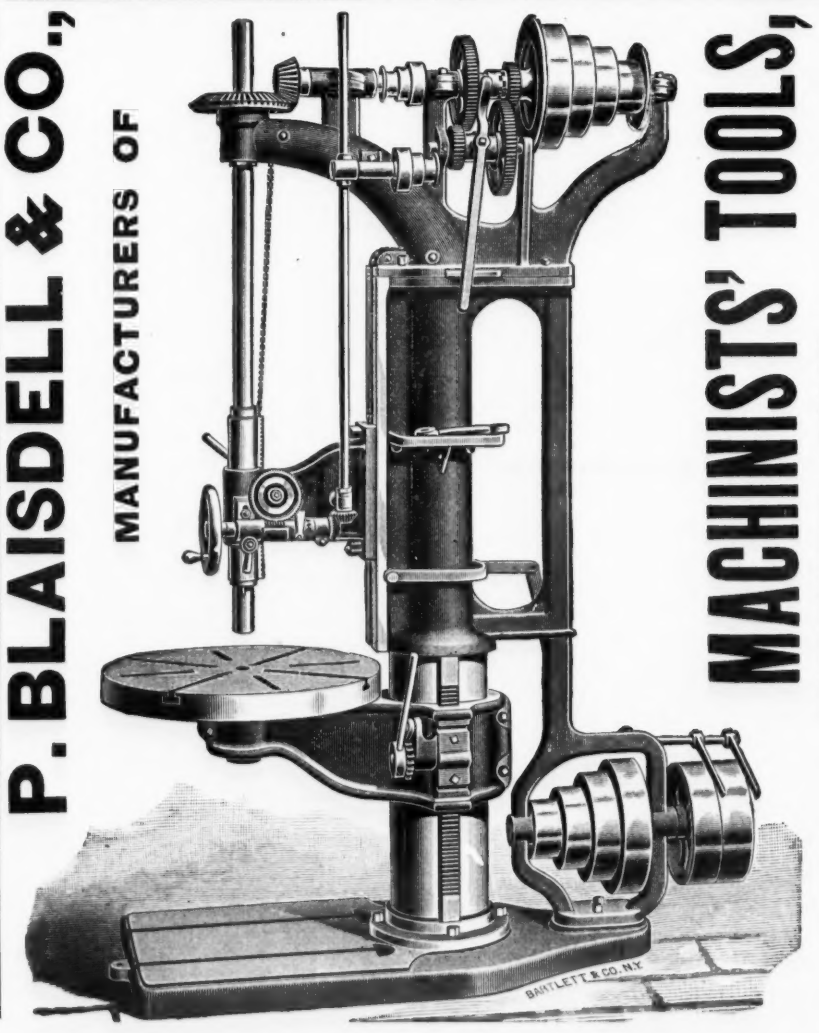

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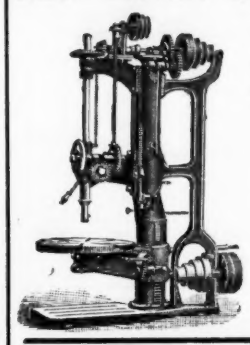

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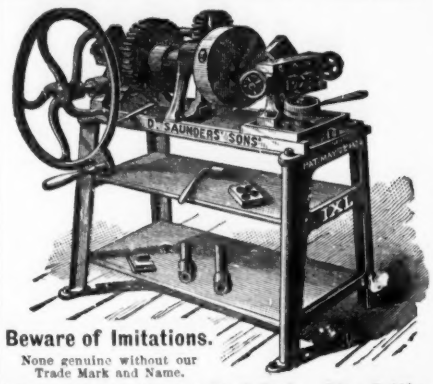

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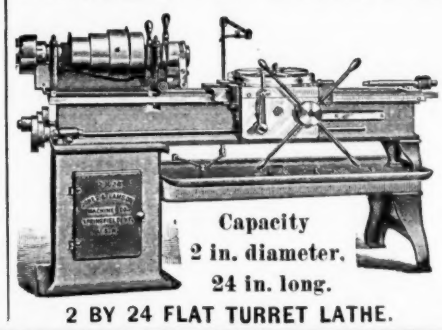

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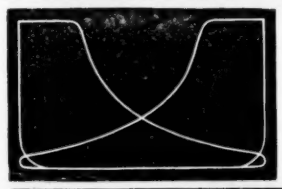

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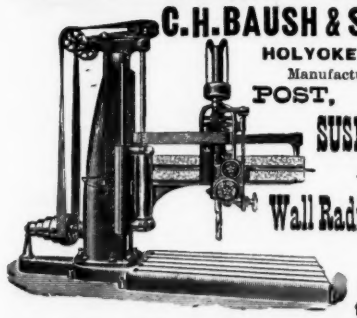

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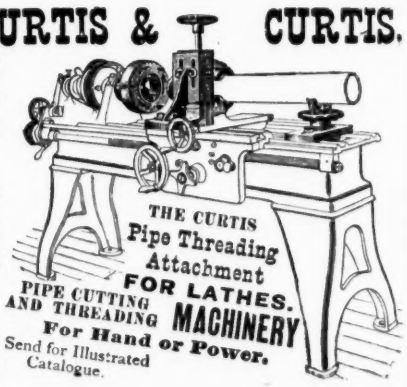

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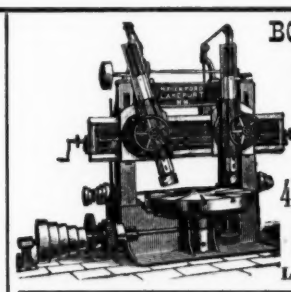

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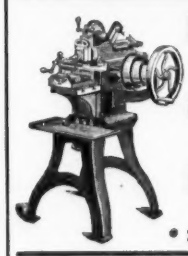

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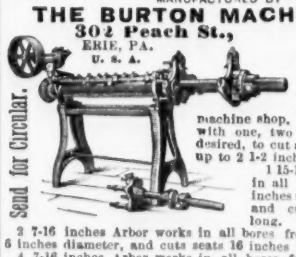

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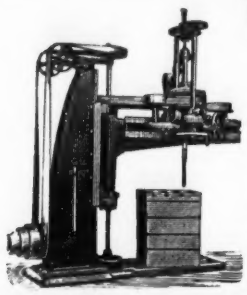

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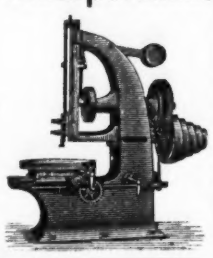

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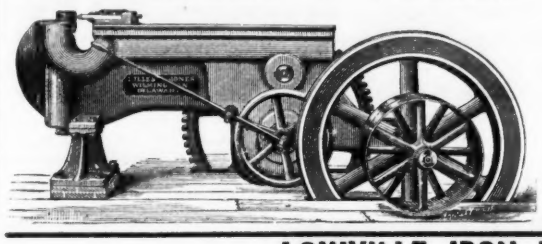

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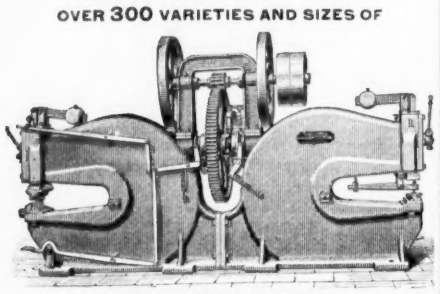

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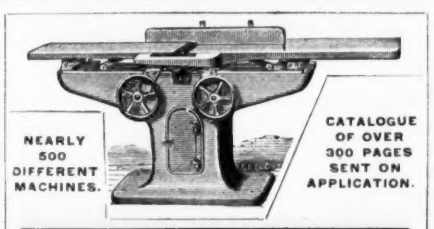

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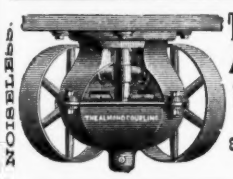

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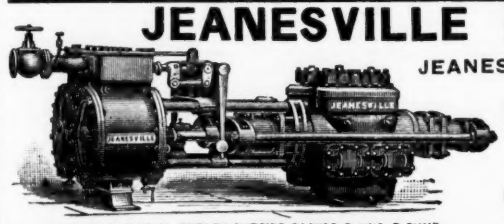

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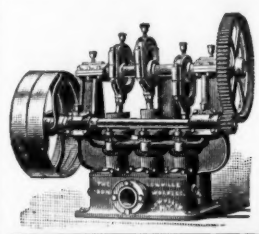

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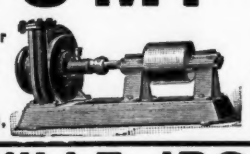

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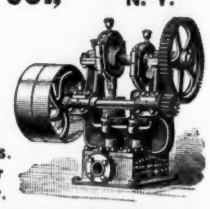

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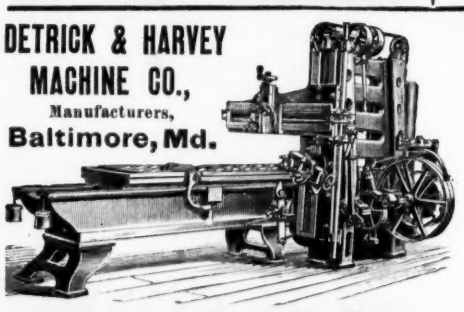

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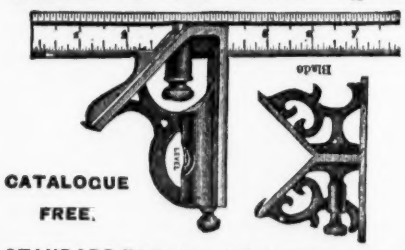

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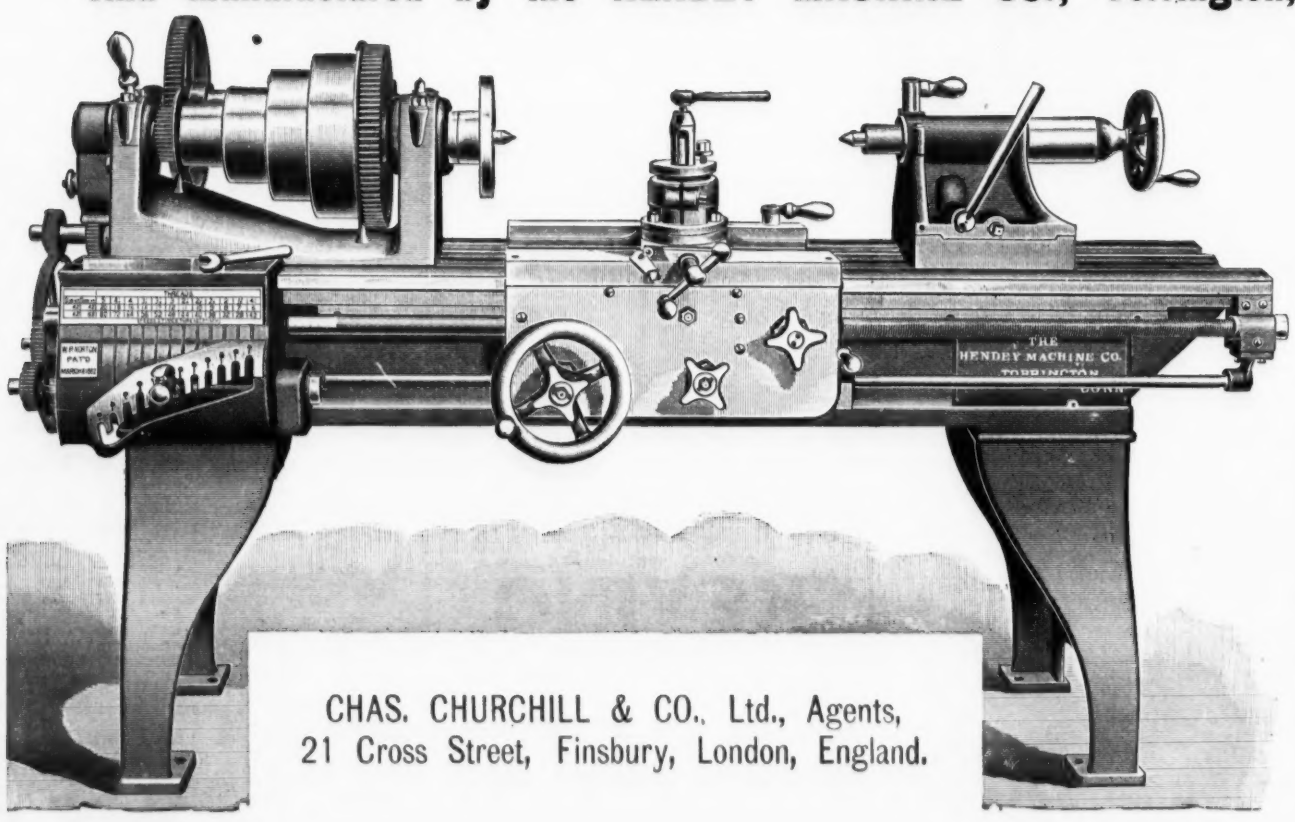

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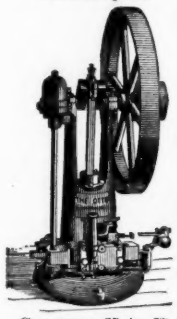

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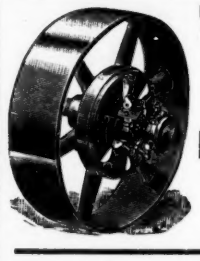

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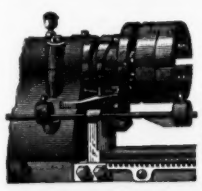

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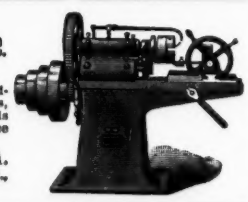

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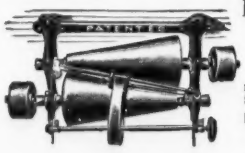

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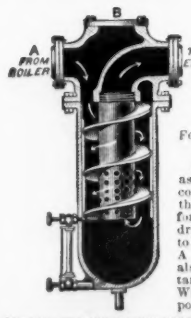

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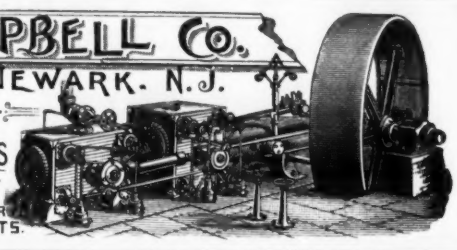

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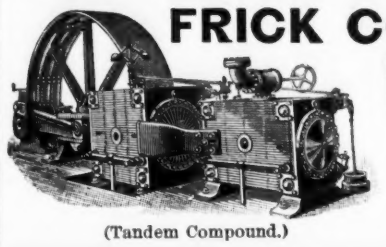

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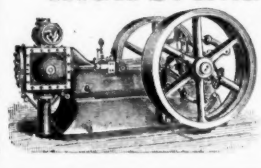

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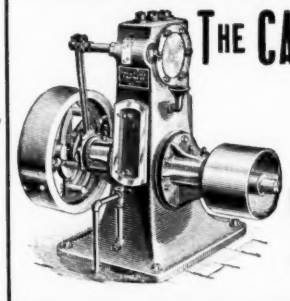

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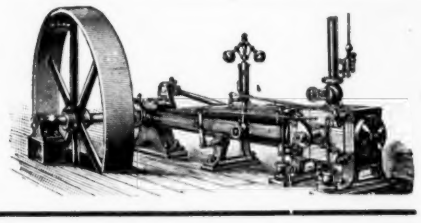

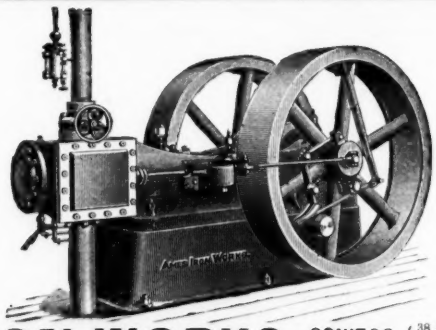

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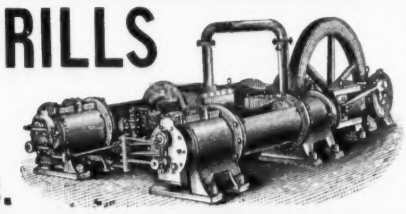

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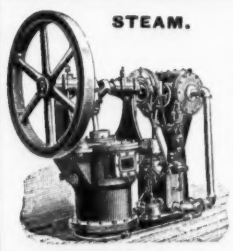

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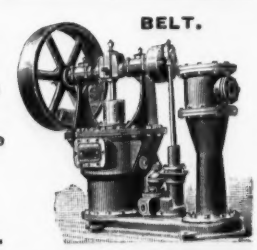

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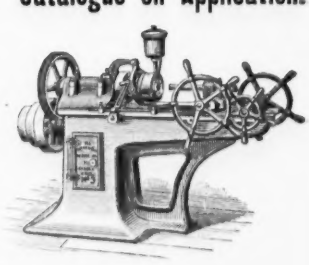

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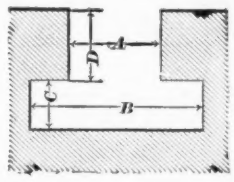

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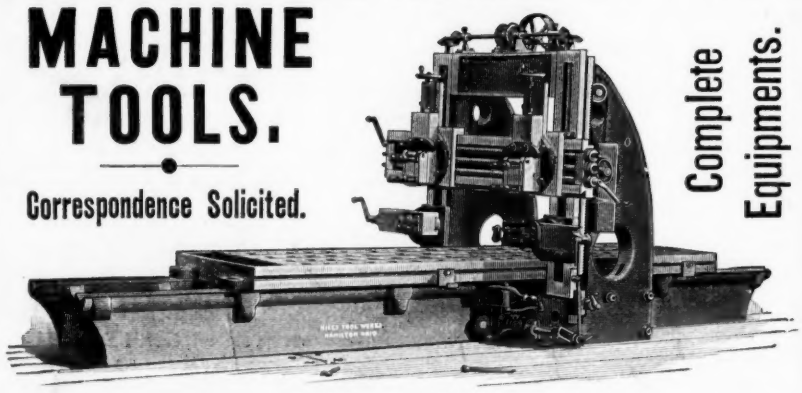

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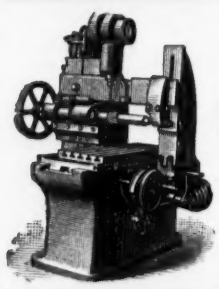

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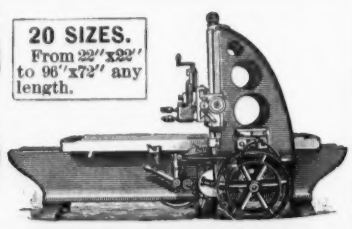

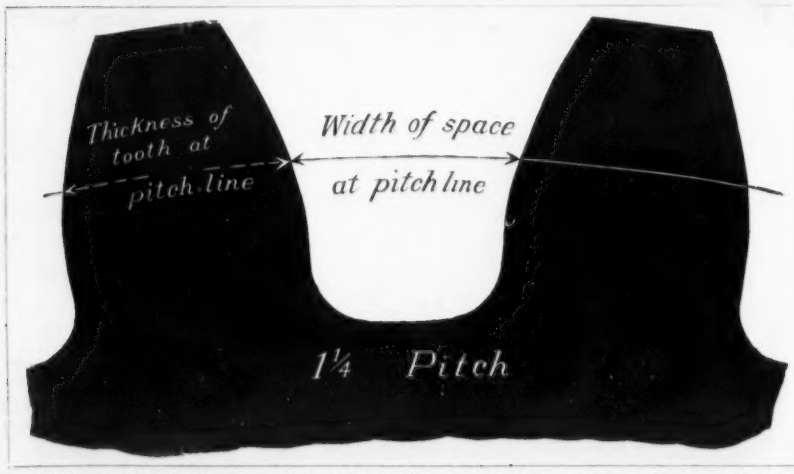

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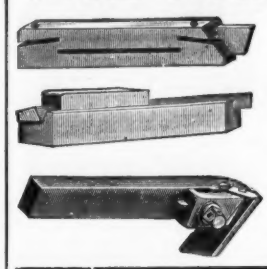

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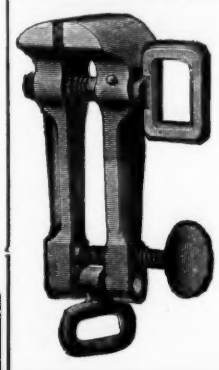

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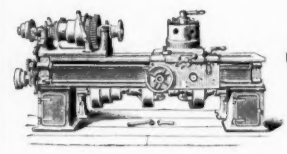

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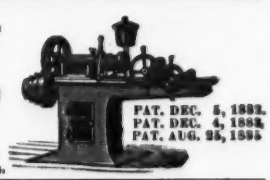

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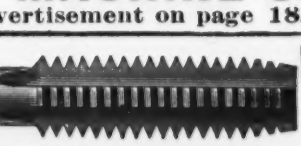

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